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BRIEFLY TOLD.

THE SAGE OF PAWTUCKET RECEIVES HIS FRIENDS.—Some time ago we announced that Mr. Samuel G. Stiness, the veteran Manager of the Pawtucket (R. I.) Gas Company, would receive the congratulations of many of his friends on the occasion of the date which marked the 30th anniversary of his connection with the gas business, 25 years of which had been passed in the service of the Pawtucket Company, and it is now our pleasant task to report that the congratulations were duly tendered, and that Mr. Stiness and his friends and confreres enjoyed a rarely fraternal time. The mention of the name of Mr. Stiness recalls many things in connection with the gas business of this country, and of the relations of the Eastern gas maker in particular to the trade as a whole. Thirty years ago, or when Mr. Stiness first cast his lot with the industry, which has grown to such enormous proportions, gas making was not the scientific operation that it is to-day; for chance, indifference and secrecy were the guiding "principles" of a quarter of a century ago, whereas intelligent method, constant application, and perfect openness are now the vogue. In fact, we might go further and say that they will be the vogue for all time to come, so far as the trade of the gas maker is concerned. And what we desire to lead up to by this reference is that it took undoubted courage and much steadfastness in the days of the Sixties for a newcomer in the trade to say to the ruling dynasty of that time that their methods and practices were faulty and improper. But of such stamp was Mr. Stiness, who, with J. B. Blake, A. B. Slater, Sr., and others of their beginning time, was not afraid to say that chance could not be allowed to prevail, when it could be so easily and safely replaced by intelligent method. However, Mr. Stiness, along with the other progressive spirits, held on to his preaching and practice, with the result that chance was routed, and real progress began. The younger men of the profession, as it stands to-day, will never really comprehend the status of the gas business of the sixties, simply because if the hard facts were arrayed before them they would think, if they did not say so openly, that the compiler was romancing. Still, whether their newer contemporaries are able to give them due credit or not, it nevertheless remains that the pioneer reformers are those to whom the youngsters of to-day owe the comparative smoothness of their present places, and the old-timers will be more than satisfied to applaud the efforts of their lieutenants to outdo the successes achieved in the days gone by. All this, of course, is foreign to the pleasant happenings of July 7th in Pawtucket, when Mr. Stiness was the glad host who received the congratulations of 43 of his fellows, all prominent in the profession to which they have devoted their lives. The idea of the descent upon Pawtucket originated with the Guild of Gas Managers—than which no more fraternal body of men engaged in like pursuit exists to-day—and subsequently the thought was enlarged by proposing to include the Society of Gas Lighting in the affair—Mr. Stiness, of course, is a valued member of both Societies. The notice to the Society of Gas Lighting, however, was too brief to permit the members this side of Connecticut to make their arrangements to visit Pawtucket on the day in question. As it was the Society was well represented by its membership in the Eastern States, and New York had delegates in the persons of Col. Benson and Dr. Wilkinson. A guest of prominence, too, was Mr. Barker, of the Massachusetts Board of Gas and Electric Light Commissioners,

whose presence at a gathering of gas men of any sort in the late sixties and early seventies would, to say the least, have been viewed with suspicion. The visitors were received at the handsome offices of the Gas Company, in Music Hall building, where Mr. Stiness played the role of host in his hearty fashion. The Palace Bowling Alleys were then besieged by the boys, where joviality ruled until noon, when the handsome and complete works of the Pawtucket Gas Company were thoroughly inspected and admired. The day's entertainment and congratulations were brought to a close by a dinner superbly served in the Assembly Rooms of Music Hall, where good-fellowship and fraternity ruled supreme. It pleases us greatly, too, to be able to say that Mr. Stiness is better in health to-day than he has been for years, and those who are close to him know that his struggle with bodily ills has been long and severe. The descent upon Pawtucket was well planned and well executed, and those who participated in it will long cherish the memory of its fraternal happenings.

THE DECISION IN THE HAVERHILL (MASS.) GAS RATE CONTENTION.—In our item columns will be found the full text of the decision of the Massachusetts Board of Gas and Electric Light Commissioners, in the matter of the petition of certain gas consumers of Haverhill to have the local gas rate reduced. Anyone who reads the decision cannot fail to be convinced of its positive fairness, both to the petitioners and the respondents, and all must admire the courage of the Board in its candid declaration that the Company is entitled to and should receive the commendation of those whom it served. The Haverhill Company's proprietors have all along been guided in their policy by motives of fairness to their patrons and justice to themselves, and the net result has been that when they were attacked, and when their course had been laid under review, they were sustained. The Commissioners are worthy of praise in that they were not influenced by public clamor, but settled the case on its merits. It is possible that we are now at the end of the outbreak of appeals for lower priced gas in the State of Massachusetts, which outbreak seemed to have its inception in the unquiet raised by the shouts, a year or so ago, of Boston's *hoi polloi* for dollar gas.

A READABLE BOOK.—"The Lighting of Paris," by M. Henri Marechal, who is an engineer of roads and bridges, in the service of the city of Paris (a book of 500 pages, with 211 cuts illustrating the text), has been placed upon the market by Messrs. Baudry & Co., of Paris, who price it at $4. Of course, the importance of such a subject as the municipal lighting of the handsomest city in the world is sufficient cause for the appearance of M. Marechal's volume. The greater number of the chapters are devoted to the illumination of the city by gas and electricity, and the author goes into the details of each system with great minuteness. The Paris Gas Company, with its 9,000 employees and its main system of not less than 1,500 miles of pipe, receive close attention from the author; and the history of what it does to light Paris by night, so far as that lighting interests the public, is most interesting. He also devotes goodly space to the electric lighting of the city, and his account of the same is simple, concise and interesting. One thing, however, that M. Marechal most clearly shows, is that the gas lighting of a city can be carried on with ease and simplicity, even if the gas works required to keep it up are huge, whereas the electric lighting maintenance is complex and uncertain, even though the electric plants are small by comparison with the gas stations.

NOTES.—"Harry" Floyd is a father, which, of course, means that he is happy, and would not exchange his lot for garlands and gold, although the Floyd family, by the way, have a trifle of both of the aforesaid belongings.——The La Crosse (Wis.) Gas Company has changed hands, having been purchased by Messrs. Dawes and Rogers, of Chicago. ——At the annual meeting of The Gas Light Company, of Columbus, Ga., the Directors chosen were Messrs. T. E. Blanchard, J. B. Holst, D. F. Wilcox, T. D. Huff and W. L. Clark. The Directors elected the following officers: President, T. E. Blanchard; Secretary and Treasurer, T. D. Huff; Superintendent, E. H. Jenkins. The usual semi-annual dividend was declared, the usual sum was placed to the credit of the sinking fund, and a bit of extra cash was carried over. The Company has had a steady increase in output for the past three months over the same months of last year.——Philip Flor was arrested some days ago at Buffalo, N. Y., charged by the Mutual Gas Light Company of that city with having bye-passed a meter, and obtaining a supply of gas for his residence without paying therefor.——We understand that "The Arlington" has been selected as headquarters for the forthcoming annual meeting of the American Gas Light Association, to be held in Washington, and that the Real Estate Exchange, four blocks away from The Arlington, has been designated as the place in which the business sessions will be held.

[Prepared for the JOURNAL.]

Electric Lighting Versus Gas.

By MR. EDWARD M. HARRIS.

Much interest has of late been displayed, and is still being taken, by our British cousins, touching the relative advantages of the electric and gas light; and in several localities the matter has been, and still is being, ventilated in all its bearings, not only at local public meetings, but in young men's clubs and debating societies, with varying results.

The advocates of both systems of lighting have spared no trouble in obtaining reliable informations, the opinions of the consumers of both lights, and in collecting and consulting statistics; not only this, but considerable sums of money have been expended in making comparative tests and various experiments.

Arguments, statements and opinions multifarious, have been adduced and put forward at these gatherings, which frequently led to lengthy and excited discussion. The meetings, however, appeared to please, instruct and entertain the audiences, and, not unfrequently, quaint and original remarks of the speakers called forth applause and merriment. It must be conceded that the decisions arrived at have preponderated adversely to the advocates, admirers and supporters of the system of electric lighting, and this is saying much, considering so many phases of the subject have been so thoroughly and so vigorously combated by speakers favoring each system.

The supporters of gas lighting called particular attention to the great responsibility the officials of towns, villages, districts and parishes, entrusted with the expenditure of the peoples' funds, assume, and to how careful they should be, before embarking in new undertakings, to assure themselves that such enterprises would prove profitable and beneficial, in all respects, to the people who confided in them, remarking how very easy it is to enter upon the expenditure of taxpayers' money, and how difficult to stop, or even control, the outlay, after being once committed to a scheme, citing numerous instances where public money had been voted, on estimates supported by tenders, for accomplishing the work, and where the original amounts had been enormously exceeded; and cases were cited where large sums had been utterly lost, and the works, undertaken with the object and expectation of proving a public benefit, had turned out to be a permanent burden on the tax or ratepayers.

In order to prevent such results by the installation of electric light in localities contemplating its adoption, the supporters of gas urged that taxpayers insist that no tender should be accepted in which the contractor does not take the risk of supply for a stated period, arguing that, although it should turn out that such contractor reaped a profit thereby, which the community would have secured, it would be better so than that the community should be saddled with a loss, and even a possible permanent charge. A clause in the contract should provide that at the expiration of the term of probation, the town, village or parish, as the case may be, shall be empowered to take over the plant, at a prescribed time, upon a valuation, in accordance with the general legislation upon electric lighting which exists in England. By this means the community, in event of success, will be assured of a good thing, and secure an installation that will likely work in the best and most economical manner, because the contractor will do his utmost to secure a large additional gain to that which he would derive from the mere profit on the initial outlay, and, in case of failure, no loss would accrue to the taxpayers of the locality.

Numbers of circumstances attending the introduction and employment of electricity in different places in England were instanced, among them the estimate for the installation of electric lighting of St. Pancras Parish, London, which was originally $250,000, but the report states that, in round numbers, $457,000 had been spent, and that the street lighting, by the electric light, costs $20,000 per annum, as against $6,700, the annual cost of lighting by gas.

At Brighton, the estimated cost for the installation of the electric light was $150,000, but $225,000 has already been spent, and the capital account is not yet closed. On the King's Road, 40 arc lamps replace 93 gas lamps, the current for which will cost $6,060 per annum, and to which has to be added, for sinking fund and for maintenance to the arc lamps, $1,215, and for labor, cleaning lamps, replacing carbons, etc., $1,300, making the total annual expenditure of $8,575 for electric lighting; whereas the cost of gas consumed by the 93 gas lamps, including cleaning, lighting and maintenance, was only $4,545 per annum—the extra cost of electric lighting being $4,030, or 88 per cent. in excess of the cost of gas lighting. It was declared that the gas gave a light at least equal to the electric. The sea front was illuminated by

"Whitehall" lamps, and was conceded to be one of the best lighted thoroughfares in Europe.

The Town Hall at Hove is at present lighted by gas at an annual cost of $760, and the estimate for lighting it by electric light is $1,000, and for replacement, maintenance of wires, renewals of lamps and other expenses, $1,500; total, $2,500; excess of annual expenditure over cost of gas, $1,740, or three times as much as for lighting the Town Hall with gas.

Lighting the Town Hall at Bradford, for six months, with the electric light, has cost the ratepayers $4,300, while the cost of lighting it for the like period with gas amounted only to $1,000, an excess of $3,300 over gas; and still the Corporation is asking for a further large sum of money to supplement the inefficient or insufficient electric lighting works there.

At St. Helens the Town Hall lighting, for three months with electric lights, has cost $470, while the gas light, for three months, cost $235; hence the electric lighting has proved just double as costly as gas.

In London very recently the Board of Works of the Strand District were asked $5,975 per annum, for 22 arc lamps, one-half of which were to be extinguished at midnight, and were intended to displace 67 gas lamps, costing only $2,365 per annum. The offer was declined.

Since the Mansion House, London (the official residence of the Lord Mayor), has been illuminated by the electric light, the annual expense to the Corporation has been more than twice the cost of the gas lights it replaced.

The experiences of many institutions and private firms have proved the same and fully corroborate the examples quoted. It was further shown that many other towns have largely exceeded the estimates for the installation of electric lighting, and that, in nearly all cases where such installations have been undertaken by municipal bodies, sufficient experience had not been acquired to enable them to arrive at a definite conclusion as to what would be a fair charge to make in revenue account for wear and tear and deterioration of machinery, dynamos, mains and apparatus generally; consequently, in some instances, this charge has been entirely omitted; and where made the provision for its modesty has been remarkable.

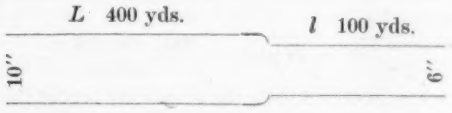
Consumers of electric light, however, do not take any great interest in the first cost of plants, etc. What they want to know is whether electric lighting will be cheaper than gas lighting, and the evidences adduced show electric lighting to be from two to three times as costly as gas.

[Prepared for the JOURNAL—Concluded from page 40.]

Distribution of Gas.

By MR. J. P. GILL.

Example 6. If the 6-inch pipe should be of a length, l, in yards, formula (A) will give with $s = .5$



$$q = 1{,}826\, d^2 \sqrt{\frac{h\,d}{l+d}} \quad \text{(Q)},$$

and formula (J) gives

$$f = H - h = .0000003 \frac{L\,q^2}{D^5} \quad \text{(R)}$$

These will give, with q, $= x$ and $h = y$, y, being the pressure at the end of the pipe D, or beginning of the pipe d.

$$x = 1{,}826\, d^2 \sqrt{\frac{y\,d}{l+d}} \quad \text{(S)}$$

$$y = H - \left(\frac{.0000003\ L\,x^2}{D^5}\right) \quad \text{(T)}$$

squaring (S)

$$x^2 = (1{,}826)^2 \frac{d^5\,y}{l+d},$$

and substituting for y its value in (T),

$$x^2\ (1{,}826)^2 \frac{d^5}{l+d}\left[H - \left(\frac{.0000003\ L\,x^2}{D^5}\right)\right]$$

Reducing this equation, the following general equation for the solution of this problem is obtained:

$$x^2\,[D^5\,(l+d) + d^5\,L] = 3{,}333{,}333.3\ H\,d^5\,D^5 \quad \text{(U)}$$

putting for the letters their values, viz.:

$D = 10$, $d = 6$, $L = 400$, $l = 100$, $H = 2$, $d^5 = 7{,}776$,

$x^2\ [100{,}000\ (100 + 6) + 7{,}776 \times 400] = 3{,}333{,}333.3 \times 2 \times 7{,}776 \times 100{,}000$.

$x^2 = 378{,}107{,}130$.

$x = 19{,}445 = q$.

By equation (O), and substituting,

$$y = h = 2 - \left(\frac{.0000003 \times 400 \times 378{,}107{,}130}{100{,}000}\right) = 2 - .45373 = 1.54627.$$

Proof: $q = 1{,}826\, d^2 \sqrt{\frac{h\,d}{l+d}} = 1{,}826 - \times 36 \sqrt{\frac{1.54627 \times 6}{100 + 6}} = 65{,}726.7 \times .29584 = 19{,}445$, as above.

Example 7.—There is a 10-inch pipe 1,500 yards long, and there are taken off, at the distance of 500 yards, 10,000 cubic feet of gas; at the distance of 1,000 yards, 6,012 cubic feet, and at the distance of 1,500 yards, 5,000 cubic feet; total, 21,012 cubic feet. What will be the pressure under which the gas leaves the 10-inch pipe at these three different points?

By the conditions above named,

21,012 cubic feet will pass through the first 500 yards.

11,012 cubic feet will pass through the second 500 yards.

5,000 cubic feet will pass through the last 500 yards.

Let the pressure of the holder be $H = 2$ inches, and let $s = .5$. The 10-inch pipe 1,500 yards long will, by formula (A), deliver 21,012 cubic feet, and the pressure at the end of the pipe will be

$$h = \frac{H\,D}{L + D} = \frac{2 \times 10}{1{,}500 + 10} = .013245.$$

This is nearly the 80th of an inch, and is too small for any practical purpose. That it is correct, formula (C) will show.

$$q = 1{,}826\, D^2 \sqrt{h} = 1{,}826 \times 10^2 \sqrt{.013245} = 21{,}012.$$

As 21,012 cubic feet passes through the first 500 yards, and this is a less quantity than a 10-inch pipe 500 yards long will deliver, formula (K) must be used to find the friction.

$f = .0000003 \frac{L\,Q^2}{D^5}$. By substituting the given values,

$$f = .0000003 \frac{500 \times (21{,}012)^2}{100{,}000} = .662.$$ Hence,

$h = 2 - .66 = 1.34$, which is the pressure at the end of the first 500 yards.

11,012 cubic feet passes through the second 500 yards, and formula (K) gives

$f = .0000003 \frac{500 \times (11{,}012)^2}{100{,}000} = .19$, the loss of pressure by friction in the second 500 yards. Hence, $.66 + .19 = .85$, the total loss in the 1,000 yards, and $2 - .85 = 1.15$, the pressure at the end of 1,000 yards. This pressure might be obtained by deducting .19 from the pressure at the end of the first 500 yards; viz., $1.34 - .19 = 1.15$.

5,000 cubic feet passes through the last 500 yards, and the formula gives $f = .0000003 \frac{500\,(5{,}000)^2}{100{,}000} = .04$, the loss of pressure by friction in the last 500 yards.

Hence $.66 + .19 + .04 = .89$, the total loss by friction in the 1,500 yards, and $2 - .89 = 1.11$, the pressure at the end of the pipe. This may also be obtained by deducting .04 from the pressure at the end of the 1,000 yards, viz., $1.15 - .04 = 1.11$.

The pressures, therefore, at the different points are—

At the end of	500 yards	1.34 inches.
" "	1,000 "	1.15 "
" "	1,500 "	1.11 "

We have seen above that the pressure at the end of the 10-inch pipe, when the gas is all delivered freely at that point, is only .013¼ inches. By taking a part of the gas off on the line of the pipe in the way named, the pressure at the end of the pipe is 1.11 inches, a gain of nearly 1.1 inches.

1.11 inches pressure is sufficient to supply the burners, whereas .013 is much too small for the purpose.

This calculation demonstrates by definite figures that a pipe delivers the same quantity of gas under higher pressure when a portion of it is delivered on the line of the pipe; or *may* deliver more gas with the same final pressure if it is sufficiently high.

Example 8.—Suppose, the other conditions being the same, that 10,000 cubic feet are taken off at the end of 500 yards; 8,000 cubic feet are taken off at the end of 1,000 yards; 7,000 cubic feet are taken off at the end of 1,500 yards; making a total of 25,000 cubic feet, an increase of 3,988 cubic feet over the preceding example, or more than 15 per cent. What will be the pressure at the end of pipe?

The following formula will furnish it; by (J):

$$f = \frac{.0000003}{D^5}(l\,q^2 + l'\,q'^2 + l''\,q''^2) \ldots\ldots\ldots \quad \ldots\ldots\ldots \text{(V)}$$

l, l' and l'' being the respective lengths of 500 yards each, and q, q' and q'' the quantity of gas passing through each length, viz.:

Through the first 500 yards, 25,000 cubic feet.

Through the second 500 yards, 15,000 cubic feet.

Through the last 500 yards, 7,000 cubic feet.

Since l, l' and l'' are equal, the formulas may be reduced to

$$f = \frac{.0000003 \times 500}{100{,}000}(q^2 + q'^2 + q''^2) = \frac{.0000003 \times 500 \times 899{,}000{,}000}{100{,}000} = 1.35$$

and the pressure at the end of the 1,500 yards will be $h = H - f = 2 - 1.35 = .65$ inch.

The pressure at the end of

500 yards	is	1.06	inch,	10,000	cubic feet	being	delivered	at this point.
1,000	"	.72	"	8,000	"	"	"	"
1,500	"	.65	"	7,000	"	"	"	"
Total.....				25,000				

This shows a gain in both the quantity of gas and in the pressure; the quantity delivered freely at the end of the 10-inch pipe being only 21,012 cubic feet, with a pressure of .013 inch; a result that may be compared with that in Example 7.

Example 9.—Let there be a pipe with a diameter = D, and length = L in yards. Let L be divided into any number, say n parts, each part being equal to l yards. How much gas, q, can be delivered at each one of these parts and the pressure, h, at the end of the pipe be equal to 1 inch?

By formula (V)

$$f = \frac{.0000003}{D^5}(l'\,q'^2 + l''\,q''^2 + l'''\,q'''^2 + \ldots\ldots\ldots + l^n q^{n2}) \ldots \text{(W)}$$

Since l', l'', l''', l'''' ..... and l^n are equal, and q', q'', q''', q'''' ..... and q^n are proportional to the parts, (W) may be reduced to

$$f = \frac{.0000003\ l}{D^5}(q'^2 + q''^2 + q'''^2 + \ldots\ldots\ldots + q^{n2}) \ldots\ldots \text{(X)}$$

And since the quantity q' passes through the last division of the pipe, and $2\,q' = q''$ through the last but one, and $3\,q' = q'''$ through the last but two, and so on, and $n\,q' = q^n$ through the first division, and since $(2\,q')^2 = 4\,q'^2$, and $(3\,q')^2 = 9\,q'^2$, and $(n\,q')^2 = n^2\,q'^2$, formula (X) may be thus stated:

$$f = \frac{.0000003\,l}{D^5}(q'^2 + 4\,q'^2 + 9\,q'^2 + 16\,q'^2 + \ldots\ldots\ldots + n^2\,q'^2),$$ and therefore—

$$f = \frac{.0000003\ l\ q^2}{D^5}(1 + 4 + 9 + 16 + 25 + \ldots\ldots\ldots + n^2) \ldots\ldots \text{(Y)}$$

This is the general equation for the solution of the problem.

Making use again of a 10-inch pipe for the convenience of calculating, though of course any sized pipe would answer as well, let $D = 10$ inches, $L = 2{,}000$ yards, $n = 100$ parts, $l = 20$ yards, $H = 2$ inches, and $s = .5$, then $H - h = 2 - 1 = 1 = f$, and putting $q = x$, we have, by substituting the numerical values in (Y)—

$$1 = \frac{.0000003 \times 20 \times x^2}{100{,}000}(1 + 4 + 9 + 16 + \ldots\ldots\ldots + 10{,}000);$$ therefore,

$$x^2 = \frac{100{,}000}{.0000003 \times 20 \times (1 + 4 + 9 + 16 + 25 + \ldots\ldots\ldots + 10{,}000)}$$

The sum of the numbers in the parenthesis being 338,350, we have—

$$x^2 = \frac{100{,}000}{.0000003 \times 20 \times 338{,}350} = \frac{100{,}000}{2.03} = 49{,}261,$$ and

$$x = \sqrt{49{,}261} = 222 \text{ cubic feet} = q.$$

$222 \times 100 = 22{,}200$ cubic feet delivered by the pipe with a pressure of 1 inch at the end.

A 10-inch pipe 2,000 yards long will deliver, when the gas is all discharged freely at the end, only 18,212 cubic feet with a pressure of .00996, or about $\frac{1}{100}$ of an inch.

This formula has reference to the case in which the gas is consumed pretty generally along the line of the pipe.

The four last general formulas are now brought together for the sake of easy reference.

$$\text{(P)}\quad q^2\,(D + L\,d^4) = \frac{1{,}666{,}666.6}{s}\,H\,d^4\,D^5,$$

in which D is the diameter of any length L; d the smaller diameter of a reducer at its end; q the quantity of gas discharged through the reducer, with the initial pressure H.

$$\text{(U)}\quad q^2\,[D^5\,(l + d) + d^5\,L] = 3{,}333{,}333.3\,H\,d^5\,D^5.$$

This formula being applicable to the case where a pipe of a larger diameter D, and of any length L, is continued by a pipe of a smaller diameter d and of any length l; q being the quantity of gas discharged at the end of the smaller pipe.

$$\text{(V)}\quad f = \frac{.0000006\,s}{D^5}(l\,q^2 + l'\,q'^2 + l''\,q''^2 + \ldots\ldots\ldots + l^n\,q^{n2})$$

in which l, l', ... l^n are any equal or unequal subdivisions of the whole length L, and q, q', q'' ..... q^n any equal or unequal quantities of gas delivered at the terminations of l, l', l'', etc.

$$\text{(Y)}\quad f = \frac{.0000006\ s\ l\ q^2}{D^5}(1 + 4 + 9 + 16 + 25 + \ldots\ldots\ldots + n^2)$$

in which n is any number of equal parts into which L is divided, l = one of those parts, and q the quantity of gas discharged at each of them, it being the same at each length l.

There have been instances in which trouble has occurred with consumers' lights, the supply of gas not being sufficient to furnish the required amount of light. On referring to the tables usually published, which give the flow of gas through pipes, it was noticed that the mains were large enough to supply all the gas that could be consumed by the burners in use. The more the annoyance was thought over, the more inexplicable it seemed.

It consisted simply in this—that while, by the table, the mains delivered all the gas required, it was delivered under a pressure so low that the lights were necessarily defective; in other words, the mains were really too small. By the formulas given above, the pressure at any point on the line of distribution may be either accurately or approximately ascertained.

Examples 5, 6, 7 and 8 also demonstrate that a distributing pipe should not be diminished in area between the works and the farthest point of distribution.

It is often thought, because a part of the gas is delivered on the line of the pipe, and less gas is required the farther it is distributed, that the area of the pipe may be reduced in proportion the lessened quantity of gas used.

This is obviously an error, because although the required quantity of gas at the terminal end is less, it is distributed under a reduced pressure, and a smaller pipe with that reduced pressure will not deliver the quantity needed. It would be better to enlarge rather than diminish the area of the pipe or its branches, with a view to lessen the loss by friction and thus increase the pressure under which the gas is delivered to the consumer.

Example 10.—By way of illustration, let a 10-inch pipe be 1,000 yards long, with a pressure of 2 inches, and the gas of specific gravity .5. Let half of what it will discharge be taken off at a distance of 500 yards. Would it be proper to reduce the 10-inch pipe to one of a smaller diameter at the beginning of the last 500 yards, or should it be continued to the end of the 1,000 yards?

A 10-inch pipe, under the conditions named, will deliver 25,692 cubic feet with a pressure of .0198. Half of this quantity is 12,846 cubic feet. The first 500 yards will therefore pass 25,692 cubic feet and the last 500 yards 12,846 cubic feet.

Now $f = \frac{.0000003\ L\,Q^2}{D^5} = .0000003 \times \frac{500 \times 660{,}066{,}006}{100{,}000} = .9901$

$h = H - f = 2 - .9901 = 1.0099$, the pressure at end of the first 500 yds.

$f = .0000003\frac{L\,Q^2}{D^5} = .0000003 \times 500\ (12{,}846)^2 = .2475.$

$h = 2 - .9901 + .2475 = 2 - 1.2376 = .7624$, the pressure at end of the last 500 yards.

A 6.6-inch pipe, 500 yards long, with a pressure of 2 inches, will deliver 12,837 cubic feet, the half of what the 10-inch pipe will deliver at 1,000 yards. Now, using for the last 500 yards a 6.6-inch pipe instead of the 10-inch, what will the result be?

A 6.6-inch pipe, 500 yards long, with a pressure of 1.0099 inch, will deliver 9,132 cubic feet under a pressure of .0132 inch. A quantity and pressure very much less than the 10-inch pipe would deliver if continued to the end of the 1,000 yards.

The 10-inch pipe, 1,000 yards long, having 12,846 cubic feet taken off at 500 yards, would deliver more than 12,846 cubic feet of gas, but at a reduced pressure, a result not to be overlooked.

In reference to the distribution of gas through smaller pipes of equal area with and branching from a distributing main, it is generally known that there is an increased loss of pressure by friction. The following calculation may, however, be of use practically and by way of illustrating, in an interesting way, the degree to which the pressure is lost by friction in pipes.

If several branches lead off from a larger pipe near its termination, the sum of the areas of the branches must be greater than the area of the larger pipe, for the reason that the sum of the circumferences of the

branches is greater than the circumference of the larger pipe, while the areas are equal. The area of an 8-inch pipe being equal to the sum of the areas of four 4-inch pipes, but the sum of the circumferences of the four 4-inch pipes being double that of the 8-inch pipe, the friction from that source is of course doubled, and the four 4-inch pipes will not deliver the quantity of gas given them by the 8-inch pipe.

Example 11.—To ascertain how many branch pipes are required to deliver the quantity delivered to them, find how much the larger pipe will discharge; then how much a branch will discharge. Divide the former by the latter and the quotient will be the number of the branch pipes required to discharge the gas supplied to them by the distributing pipe at or near its end.

An 8-inch pipe 1,000 yards long, pressure 2 inches, with gas of specific gravity of .5, will deliver 14,721 cubic feet.

A 4-inch pipe 1,000 yards long will deliver 2,608 cubic feet, and there will be required 5.64, say six 4-inch pipes to deliver the 14,721 cubic feet. If four 4-inch pipes are used they will deliver only about 71 per cent. of the gas supplied to the 8-inch pipe, although they are equal in area to it.

Example 12.—Suppose a gasholder, having a pressure of 2 inches, is filled with gas from another having 3 inches pressure, and a gas pump is used to force the gas through a 10-inch pipe 1,000 yards long, being the distance between the two holders. Ought the pump to be located near the No. 1, the supply, or the No. 2, the receiving holder?

A 10-inch pipe 1,000 feet long, with gas of specific gravity .5, will deliver under a pressure of 3 inches 31,466 cubic feet per hour. In this instance, there is a counter pressure of 2 inches, leaving 1 inch for a working pressure, and the pipe will deliver only 18,167 cubic feet per hour.

A pump placed near the No. 1 holder must work with a pressure of 5 inches to deliver the same quantity of gas as the holder would if the pipe discharged freely.

If placed near the No. 2 holder, the pump would have to work against but 2 inches pressure, which would then cease to act as a back pressure on the No. 1 holder, and the pipe will deliver as much as if the gas passed freely.

Now the horse power required to do work is proportional to the work to be done, and therefore the pump will require 2½ times the power to operate against 5 inches as it would against 2 inches pressure, and the expense in steam would be 2½ times less with the pump at the No. 2 holder.

Moreover, if the pipe were large enough to deliver all the gas that could be pumped with the larger horse power, 2½ times the work would be accomplished with the same expenditure of steam as at the No. 1 holder. A 14-inch pipe will deliver nearly 2½ times more gas than the 10-inch. This would be a much larger quantity of gas delivered with the same expense of material and with the saving of labor, the work being done in 1 instead of 2½ hours. Thus in either case it will be economy to place the pump at or near the No. 2 holder, with the additional advantage of relieving the main from the increased pressure and leakage.

If the gas were delivered through a distributing pipe instead of the simple feed pipe, allowance would of course have to be made for the altered conditions, but the principle would remain intact.

Illuminating Power and Illuminating Effect.

[A paper read by Mr. Thomas Newbigging, of Manchester, before the Incorporated Gas Institute.]

I do not propose to trouble you with a dissertation on the standard photometer; you will get that in the text books. Besides, you are all familiar with the apparatus. Neither do I intend to discuss the relative merits of the various appliances now in use, or proposed, for determining the illuminating power of gas flames. I will not even canvass the respective merits or demerits of the standard candle, the Carcel lamp, the Methven screen, or the pentane flame—whether of one candle or ten candles value; nor will I set before you a long array of figures, tabulated or other, giving the results of elaborate investigations and tests of different qualities of gas and burners. All that is beside my purpose on this occasion, I am going to speak of "Illuminating Power" in the abstract, and to give utterance to certain views—some will call them heretical opinions—that have been forcing themselves upon my mind for some years past, and which are clamoring for expression; the time, as I conceive, being ripe for such expression.

It is doubtless a truism to say that illuminating power and illuminating effect are by no means synonymous; that the two expressions do not convey precisely the same idea to the experienced mind, however much they may be considered as identical by the unenlightened public. The truth of this is vividly impressed upon us by observation of the illumination afforded by the electric arc light, where there is an intense central point, with a by-no-means proportionately great diffusive power.

But I venture to carry the illustration farther; I carry the war into the camp of illumination by coal gas. Take a gas of so-called 18 standard candle illuminating power, and another gas of 14 standard candle power. The one is nearly 30 per cent. higher in illuminating power than the other. But in burning the higher power gas for lighting purposes, do we, even with the most advanced appliances, and under the best attained conditions (assuming, of course, that these are applied in the case of both the gases), obtain the advantage, or a tithe of it, which the 30 per cent. superior power would lead us to expect? I am more than skeptical on that head—I am, indeed, convinced that we do not. I will go farther, and ask: "Do we, as consumers, not rather suffer grave disadvantages in burning gas of the alleged higher illuminating value?" I again assert that we do.

When gas of the higher standard power is deteriorated even to a trifling extent (as indicated by the usual photometrical tests) by reason of inefficient purifying materials or methods, the manifest loss in illuminating effect (as distinguished from illuminating power) is increased to a vexatious extent. Hence the frequent or almost unceasing complaints of "bad gas" that prevail within the zone where the assumed or proved higher qualities are in vogue. On the other hand, there is a marked absence of such complaints in districts where the lower standard illuminating powers are supplied and used.

To put the matter in a concrete form, take the circumstances of the majority of southern towns, where the lower power gas is burned, and compare them with those of more northerly towns, where the higher power gas is supplied. In the former, the complaints of deficient illuminating quality are almost entirely confined to the official gas examiner (where such official exists). This is notoriously the case in London, where the illuminating power usually ranges slightly over 16 candles. Complaints of this character in the metropolis from the consumers themselves are exceedingly rare, and when they are made by consumers they are groundless, or are due to defects of a local kind. My experience does not lead me to say the same of complaints in the richer (so called) gas districts. Here the official examiner generally finds the illuminating power up to and above the prescribed standard when the complaints from consumers are general and persistent, and when, as I hold, there is a real grievance. It would be invidious to give the names of places (they will occur to some of you), else my argument would receive immediate confirmation.

What is the reason of this? I will not answer the question by attempting to give an explicit scientific explanation of the phenomenon, except to assert that illuminating power, as indicated by present photometrical methods, is not synonymous with illuminating effect. The said scientific explanation is not, and never has been, forthcoming in any full and satisfactory sense; and it will only be arrived at after more consideration and research than have yet been devoted to the subject.

I am going to make a bold—some may consider it a rash—statement, but it is not made without very careful thought and after long experience and observation—viz., that gas of 14 or 15 standard candle power gives, cost for cost, as good an illuminating effect as gas of 18-candle power. I go even beyond that, and assert that, under efficient pressure regulation, the lower (so called) grade quality is the better illuminator. It is easier to burn a low standard gas to advantage than gas of a high standard. Another thing I can allege—that, whereas the higher quality gas is a nuisance under consumption, the lower quality is a positive luxury in use. The first is a nuisance by reason (amongst other things) of the invariable deposit of carbon—seen in the blackening of ceilings and in other ways. True, there is a slight blackening, or rather browning, with the lower qualities, but it is infinitesimal as compared with the other, and is caused, not by unconsumed carbon, but by the dust particles carried up by the heated air currents.

"Yes," I imagine some one saying, "and in this circumstance of the deposit of unconsumed carbon, you have the explanation of the difficulty—if it can be called a difficuity—which you have raised before us to-day. Consume the whole of the carbon contained in the richer gas and your difficulty vanishes. It all, in short, resolves itself into a question of suitable appliances for burning the richer gas." Softly, my friend! I am not going to be put off with that ancient philter for allaying the ghost. I do not accept your conclusion, if that is the whole

sum and substance of it. It is too obvious—so obvious that the most liliputian intellect can grasp it. There are more things in heaven and earth than are dreamt of in your philosophy. I used to wholly explain the thing in that brusque, self-sufficing way. I have ceased to so explain it, and I now come to you practical and hard-headed gas makers and purveyors, and tell you that, if this is your ultimatum in the way of solution, it is not satisfactory to me, and I will not accept it as such. But again, will any objector to my statement be good enough to inform me what the proper appliances are for consuming high power (say, 18 to 20 candle) gas in such a way as to get rid of defective lighting and abominable carbon deposit, with general unsatisfactoriness, and where are they to be found? I have never been fortunate enough to meet with them. On the contrary, the appliances most strongly recommended for that purpose are often just those which most aggravate the evils—dirt and dissatisfaction—of which I complain, and with good reason.

Having come thus far, let me rehearse the points I wish to enforce: It does not follow that to raise the illuminating power is to increase the illuminating effect. Illuminating power (as shown by the photometer) and illuminating effect are by no means synonymous terms. The higher the standard, the greater the nuisance, or risk of nuisance, of unconsumed carbon deposit on ceilings, furniture and pictures. A low standard gas (say, of 14 or 15 candles), purified by lime, is equal in illuminating effect to the vaunted higher qualities of some places, with an absence of the nuisance of which I have spoken.

And now for the moral—though the story, like a good fable, should carry its own moral without the telling. The moral is that, during the last, say, twenty years, the public have been pursuing a mistaken course in clamoring for an increase (so-called) in the standard of illuminating power. What is wanted is a return to the lower (and better) standard—say, 14 or 15 candles (preferably 14)—with the actual supplied value approximating thereto, which, with the improved methods and appliances for burning gas, will afford a better illuminating effect than the other, with a blessed absence of nuisance. A further lesson taught us is, that the methods and instruments employed in coal gas testing do not enable us to gauge the illuminating effect of the gas; and, lacking in that respect, to rely on their indications as a proof, and the only proof, of illuminating value, is misleading and mischievous. A photometer that will measure quantity of light as well as intensity—if the invention of such an instrument is possible—is much to be desired. These two old-word and suggestive terms, ***quantity*** and ***intensity***, have, of late years, almost passed out of the gas maker's vocabulary; but they greatly need reinstating, with all the pregnant facts and associations which surround them.

A yet further moral derived is, that enriching nostrums are a snare and a delusion. They are not necessary for effective lighting; they are a backward step in illuminating by means of coal gas. Given 14 or 15 candle gas, purified by lime, either wholly or as an accompaniment of purification by oxide of iron, in such manner as to completely eliminate the carbonic acid (for this is a ***sine qua non***), and I will back it against all the other higher photometrical qualities—back it to give more satisfaction and provide fuller illumination than the other. Given such 14 or 15 candle gas, consumed under proper conditions of burner and pressure, with ventilation to insure the removal of the products of combustion, and you have a light which rivals, in point of cheapness and general efficiency, if it does not eclipse, that of any other artificial illuminant.

I repeat that photometry as at present practiced, with the instruments in use, and with the specific objects in view, is clearly at fault. Its results, or the way of stating these results, do not harmonise with everyday experience. I listen to the stories that are told of the enormous loss of light consequent on using what are described as unsuitable burners—I do not mean faulty burners, but burners that are said to be unsuitable for use with the particular quality of gas supplied—with incredulous wonder. We are assured, for example, that, tested by the standard photometer, even employing a good burner of the very best design and construction, if it be of the flat-flame type, in consuming gas of 14 to 16 candle power, there is a sacrifice of something like 40 to 60 per cent. of the available light, as indicated by the standard Argand. My experience, as a mere consumer of gas, putting orthodox tests aside, is not in accord with any such assertion. True, there may be a sacrifice of intensity in using the flat-flame, as contrasted with the standard Argand; but that there is any such sacrifice of quantity, of diffused power, of illuminating effect—of illumination, in short—I distinctly deny.

The flat-flame type of burner is assumed to be the best fitted for evolving the light-giving power of gas of 20-candle power; and hence it has been designated as the test burner for this and higher qualities. I venture to say, however, that complaints of want of illuminating power are more frequent where the two conditions of richness of gas and alleged suitability of burner are found to exist than under the other. The fact is that for all, or most, qualities of coal gas, there is but little variation in illuminating effect in using the flat-flame burner. The physical conditions under which the flat-flame burner is sometimes used, rather than the chemical conditions of the gas, will generally account for any lack there may be of illuminating effect. But I know from experience it is a fallacy to say that the flat-flame burner gives under test a higher value than the Argand with 20-candle gas and upwards. Anyone who cares to try may easily satisfy himself that Sugg's "F," or No. 2 Argand, gives photometrical results from 5 to 7 per cent. higher than the flat-flame with these qualities. These will probably be looked upon by many as heretical opinions. An acute writer has said that "a heresy is truth in the making;" and so I am consoled. I have not given expression to them without consideration. I venture to predict that they will not for long be viewed as heretical. The hour is at hand—if it has not already arrived—when the inevitable reaction against high standards and enrichment fads will begin; and then the truth of the philosophy underlying the views I have now expressed will be fully acknowedged.

The objections to all tried methods of enriching the gas derived from bituminous coal of average quality, excepting, perhaps, enrichment by means of cannel, are sufficiently serious to raise doubts, even in the minds of some of those who voluntarily resort to them, as to the alleged benefits to be derived from their adoption. The varying quality of the enriched gas, due to the stratification of gases of different specific gravities, which takes place, notwithstanding the action of the law of diffusion, and the deposition of the hydrocarbon vapors in the distributing mains and service pipes, are the principal drawbacks that are encountered—leaving out of question, for the moment, the disadvantages on which I have already dwelt. Professor Vivian B. Lewes, in the remarkable paper read by him at the Society of Arts on April 11th last, and fully reported in the ***Journal of Gas Lighting*** for April 17th, in dealing with this subject as it affects the gas supply of London, remarks:

"The official testing stations are fixed at the points where the great trunk mains deliver the gas to the districts to be supplied; and it is only under exceptional circumstances that the illuminating value of the gas is ever found to be below the required limit at these points. In these big mains the gas is continually flowing at a fairly steady rate, and is neither exposed to any great alteration in temperature, nor, from the size of the mains, to any great amount of skin friction—*i. e.*, rubbing of the gases against the sides of the pipes. But as soon as distribution commences both these factors come into play; and, as certain of the chief illuminants of the gas are vapors and not permanent gases, lowering of temperature causes condensation of some of them, while the power which friction against the sides of the mains and service pipes, coated with deposited hydrocarbons, has of withdrawing the illuminants from the gas, still further decreases its light-giving value. Moreover, anywhere near the dead end of a service, stagnation in the gas during a large proportion of the 24 hours, when gas is not being consumed, adds still further to the trouble; and, even at the testing stations the influence of the small consumption of the gas on Sundays, and consequent stoppage in the manufacture on that day, can be traced in the illuminating value found on Monday morning." This is weighty evidence of the unsatisfactory results of enrichment, coming as it does from one well qualified to express an opinion, and deserves to be well pondered by all concerned.

It is urged that the cost of enrichment by means of the hydrocarbon oils is from two-fifths to one-half less costly than enrichment with cannel; but statements of this kind must be largely discounted, in view of the drawbacks mentioned. Some things, while apparently cheap, are dear at any price.

In the paper of Professor Lewes, already referred to, the question of the composition of gas enriched by carbureted water gas is dealt with in regard to the alteration in the size of the gas flame by reason of the increase in the quantity of hydrogen and carbon monoxide, and the decrease in the percentage of methane in the enriched gas. This is worthy of attention as constituting a further objection to the use of enrichment processes.

Enrichment, unfortunately, in one form or another, is a necessity in places, owing to the action of Parliament in fixing an unduly high standard of illuminating power. But that any of the more northerly towns—say in Yorkshire or Lancashire—whose standard is fixed at 15 candles and under, should resort to enrichment, is a piece of folly that may well be discouraged.

The truth in regard to high standards and enrichment processes is that, while the augmented cost per candle is serious in amount, the advantages derived in the direction of increased illumination are trifling or nil; while at the same time they are accompanied by disadvantages that are very real. Enrichment to any great extent, even by the use of expensive cannel or shale, is to be deprecated. So far from resorting to enrichment, the wiser policy, as it seems to me, would be to reduce the illuminating value of the gas yielded by the richer coals and cannels, by a judicious admixture of the latter with inferior coals. The tendency of this would be to place the prices of coals on the one hand, and gas on the other, more on a level for the whole country, which would be an unmixed good. Why should cannel, for example, stand at such a high price? I do not think it is owing to the scarcity of cannel. Scarcety is a purely relative term. Most things are plentiful or scarce according as the demand for them rises or falls. The cost of mining cannel is no more, probably less, than that of mining ordinary coal. It is only an accident which has placed cannel beds in the hands of their proprietors, who by their possession are, under present conditions, enriched without corresponding benefit to the community at large.

The necessity for cheap gas is of the first importance in these days of competition. Cheapness is the best possible stimulant to the employment of gas for purposes other than lighting. The benefits to a town possessing a supply of cheap gas are incalculable, not only in a direct pecuniary sense, but from an industrial point of view, in the number of uses to which gas can be applied, and also as mitigating the smoke nuisance, and in this way contributing to the health and comfort of the inhabitants.

The unreasonably high standards prescribed in certain towns—as Liverpool, with 20 candles; Preston, with 18; Southport, with 20; Salford, with 18; Middleton, with 18; Wigan, with 18; and others similarly disadvantaged—are an evil both for the respective undertakings and (in an especial degree) for the consumers.

Again, incandescent lighting is being developed, and I believe is destined to be a greater factor before long; and for this reason also there is less need than ever to aim at high illuminating powers by means of enrichment. These are facts which I am convinced will be recognized by the public and by the legislature in the near future.

If anyone suggests that the fixing of a high standard tends to stimulate the invention and introduction of improved appliances for consuming gas so as to develop the highest power of which if is capable, then, whilst partially agreeing with him so long as the gas is produced from coal without addition, I also assert that enrichment cuts at the very root of invention in this direction. It is, in fact, a clumsy and expensive method of attaining an end that may be arrived at by another and more desirable way.

The reasonable policy for the legislature—as Mr. George Livesey has declared, and as it seems to me—is to fix such an illuminating standard as the quality of coal available in a district will yield. Or in places where there is no bituminous coal in their neighborhood, then the nearest available coal may regulate the standard. London and most of the southern towns, especially such as are situated on or near to the coast, owing to their geographical position, use Durham coals (sea-borne) yielding gas of 14 or 15 candle value. That, therefore, is what may be called the natural standard for such places. In towns farther north, and drawing their supplies from the South Yorkshire and Lancashire coal fields, an additional candle would not be seriously objectionable; though even here a 15-candle standard is more advantageous, even from the consumer's point of view.

I am by no means isolated in holding the views which I am now trying to propound. Mr. Livesey—to whom the gas interests (in which I include the interests of consumers not less than those of shareholders and administrators of gas undertakings) are so largely indebted, both for initiatory and progressive reforms and improvements—has suggested the reduction of the standard of illuminating power in the metropolis to the natural standard justified by the use of Durham coal. This is a policy which if, and when, carried out, will redound to the advantage of all parties, and will add further to Mr. Livesey's great reputation as a gas administrator. Some other of our ablest and most experienced gas engineers and gas chemists cherish the same views in their secret hearts; and a few (notably Professor Lewes) have ventured to express them.

What seems to have been wanted is the creation of the opportunity of enabling gas managers generally to give full and unstinted expression to their opinions. I have tried to afford such an opportunity, and if there is not an eager and emphatic declaration in favor of the policy now advocated, I shall be disappointed.

The Relations Between Gas Companies and Gas Consumers.

By Wm. Paul Gerhard, C. E., in *Cassier's Magazine*.

Not quite a century has passed since the birth of the gas industry, yet we already find gas light, in many instances, supplanted and displaced by the electric light. Even a casual observer cannot fail to notice the fact that the electric light is just now becoming "all the fashion," but does this mean that gas light is entirely doomed? Has not, on the contrary, the gas industry profited by the advent of the new light, and is it not a fact that the consumption of gas has increased in recent years instead of diminishing?

At the time when the electric light was first brought to public notice, Mr. W. H. Preece, in a lecture delivered in 1880, before the London Society of Arts, on "Recent Wonders of Light," uttered the following prophetic words: "Gas is a magnificent thing in itself, but one of the great advantages of gas has been that it has driven the candle makers and oil lamp manufacturers to give us hundred fold better things than they did before, and so the introduction of electricity, if it does nothing else, will compel our gas engineers to produce gas lighting apparatus as far superior to those of our youth as these ordinary lamps are to the oil lamps of the Greeks."

Gas lamps have taken the place of candles and oil lamps, and these same gas lamps are now in some cases replaced by electric arc and incandescent glow lamps, yet the older illuminant has in each case profited instead of suffered. Doubtless, one result of the improvements in methods of illumination has been a more lavish use of light, and the setting up of a higher standard in street as well as in domestic lighting. With the increased requirements, therefore, each kind of artificial light is benefited by the advent of its successor, competitor and rival. The electric light, in particular, awakened the managers of the gas industry into activity, and a higher quality of gas at reduced cost, better gas fittings, more efficient gas burners and gas lamps have been produced, demonstrating to a greater extent than ever before the possibilities of the "light without a wick," created from "the spirit of coal." Gas lighting has been of incalculable benefit to mankind in the past; its many advantages are at present more than ever enjoyed in the household, in the office and in the workshop, and notwithstanding contrary statements by those interested in the development of the rival light, it is my belief that for a long time to come, gas will not only hold its own, but make still further progress. The coming century will, doubtless, be the age of electricity, but ours is the era of gas.

Having thus briefly glanced at the past, present and future of gas lighting, let us consider what shall be done to strengthen the future position of gas light in view of the rapid strides made by its chief rival, electricity. Every impartial observer cannot help admitting that the future of the gas industry must, to a great extent, depend upon the relations between gas companies and gas consumers. It is well known that these relations have not, in the past, always been as pleasant as they might be. The bulk of the gas consuming public is lamentably indifferent or ignorant, or both, about the subject of gas lighting; hence, the proper use of gas in the household is little understood. A few commendable instances excepted, gas companies have made no effort whatever to keep householders and gas consumers informed on the subject. Instead of trying to gain the consumer's confidence, many gas companies and their employees have persistently pursued the erroneous policy of surrounding themselves and everthing pertaining to their business with an air of profound mystery. Worse than this, in many instances those employees of a gas company who come into closer contact with the public, often throw a veil of secrecy about the subject with a view only of hiding their own ignorance. All this is much to be deprecated, for as a natural result the consumer, already full of prejudices and dissatisfaction, becomes still more suspicious and biased. It would seem to me as if the best interests of gas companies demand that they enlighten the public, and that they help them in every way possible to consume the product of the gas works in the best manner.

Why gas companies should not make efforts to establish, or to maintain, pleasanter relations with their consumers has often been a matter of wonder to me. The interests of gas companies and gas consumers are mutual and should go hand in hand, therefore companies should constantly strive to dispel any bad feeling, to remove all prejudices and to avoid as far as possible all friction. The welfare of gas companies demands that they should not be indifferent to the wishes of the consumer. It is a fact capable of easy demonstration that where a company or its employees have taken the trouble to instruct the consumer how he can make the best possible use of gas, or how he can obtain a maximum amount of illumination from the burning of a given quan-

tity of gas, an increased consumption of gas resulted for the company. What can the gas companies do to bring about a better feeling between themselves and their consumers? First of all, gas companies should attend to the complaints of the consumers. Nothing within the bounds of reason must be left undone to satisfy them and thereby retain or gain their confidence. By far the majority of complaints are first, about bad gas or deficient light, and second, about excessive gas bills. The latter are invariably attributed to the inaccuracy of the company's gas meters, or to errors of the clerks in making out the monthly gas bills, while the deficiency of light is usually laid to the bad or poor quality of the gas or to lack of pressure in the gas mains. Occasionally, consumers grumble about the flickering of lights, about hissing and noisy flames, about the breaking of gas globes, caused by gas flames with ragged edges, about the vitiated air, about immoderate heat and the injurious effects of gas lighting upon health and comfort, and about the destructive effects of gas upon the decorations, pictures, books and furniture, the walls and ceilings of rooms.

In some cases, no doubt, there is just ground for these complaints. The gas company should then endeavor to remove the causes, if practicable. But, as often as not, the complaints of consumers arise from their own lack of knowledge, or carelessness, or indifference. Very frequently, too, the troubles complained of are a result of the stupidity or cupidity of the gas fitter or the builder, and an impartial investigation would demonstrate that the complaints can easily be traced to one or more of the following defects, over which the gas company seldom has any control, viz.: The use of gas piping of inadequate size, the improper running of gas pipes, the use of bad, cheap, or unsuitable burners, or to good burners having become obstructed or worn out; to the use of ill-contrived and light obstructing brackets and chandeliers with tubing of insufficient size; to the use of globes with narrow bottom opening made of light obstructing material and supported by heavy globe holders; or the failure of the gas light is due, in districts where a high gas pressure necessarily prevails, to the omission of pressure reducing appliances.

Consumers of gas should inquire into the subject of gas lighting without bias, and gas companies should endeavor to remove all manner of prejudices generally arising from ignorance or suspicion. Among misconceptions of consumers, the most difficult to deal with is the prejudice against the "lying gas meter." This is largely due to want of knowledge as to its construction and mode of operation. It is increased by the many stories of the vagaries of gas meters, disseminated by the daily press. Many consumers imagine that they are completely at the mercy of the gas meter, or that gas companies charge them whatever they see fit to charge. It is needless to say this is a great mistake. To remove this deeply rooted prejudice, gas companies should endeavor to teach the householder how to become familiar with the gas meter, and to encourage his frequent reading of the index, as many a serious misunderstanding may thereby be prevented.

As a matter of fact the size of a consumer's gas bill is dependent upon the quantity of gas consumed only and with this a gas company has little to do. As regards gas bills, wrong statements are rendered much less often than the average gas consumer supposes. The process of making out the bills is about as follows: Once a month the meter inspector calls at the consumers' houses, takes the reading of the meter, enters the date and the state of the meter in his record book, and returns the same to the gas company's office. Then the clerks in the office make out the bills by putting the last statement just taken at the top and the reading of the previous month under it. The latter amount is then deducted from the former, and the difference obtained is the last month's gas consumption. Errors of calculation can be prevented by checking the figures, and errors in the figures by a careful comparison of the previous and the present meter reading. Errors made in reading the meter are, as a rule, discovered at the end of the next month, it being then found that the consumer has either paid in advance or else too little, generally by an even 1,000 cubic feet. By reading his own gas meter every month, or every week, or daily, a consumer has in his hands a perfect check against fraud or mistakes.

Again, a great deal of good might be accomplished if managers and officers of gas companies would endeavor to correct and dispel the numerous popular errors or fallacies regarding gas lighting. Among the more common fallacies I will mention the following:

a. That gas companies mix air with the gas to increase its volume. This admixture of air is never attempted, because it would obviously result in a serious deterioration of the illuminating power of gas, for even a 1 per cent. admixture of air reduces the candle power of gas by 6 per cent., and a 10 per cent. admixture reduces same by 67 per cent. Gas companies are required to make and furnish illuminating gas of a specific candle power, and the weekly tests of the gas examiners show that the quality of the gas rarely falls below this standard, as it certainly would if air were mixed with the gas. It is a fact, however, not so well known, that the quality of gas is variable with atmospheric changes. For instance, a fall in the barometer reduces the brilliancy of lighting by 5 per cent. for every inch of fall. According to Dr. Letheby, "in London, the difference in the value of the light when the barometer is 31 inches as compared with what it is at 28 inches is fully 25 per cent., and this, no doubt, accounts for many of the complaints of 'bad light' in November, when the barometer is usually very low." The quality of the light is likewise said to be variable with the amount of moisture in the air.

b. That gas companies blow or pump air from the works into the gas mains during the day to make the meter go around and to make the index register. This is sheer nonsense, for not only can the consumer at any time by lighting a burner convince himself that the pipes contain illuminating gas and not air, but where no gas is burnt and the house pipes are tight, the consumer by watching the small index hand of the meter during the day will find that it remains stationary.

c. That large gas meters lead to an increase in the gas bills, and that large gas pipes in houses, as advocated by gas engineers, increase the consumption, and therefore the monthly gas bills, both of which beliefs, of course, are erroneous, as the gas consumption depends only upon the number and size of burners in use, and upon the gas pressure, but not upon the size of the conduit or pipe conveying the gas to the burner, and not upon the capacity of the instrument measuring the gas.

d. That the gas company willfully puts on more pressure at the works at night to make the gas meters in the consumers' dwellings go around faster. While the fact is true that the pressure is increased in the early part of the evening when a general lighting up begins, the gas company is obliged to do this to supply the distant consumers and those located in low level districts. The increased pressure causes increased leakage of gas at the joints of the street mains, and also leads to increased consumption at the street lamps with ungoverned burners, for which the companies, as a rule, receive a fixed annual sum by the municipality, hence it may be accepted without question that the gas companies would not increase the pressure if it were not necessary to do so.

e. That large burners lead to a waste of gas, and that where gas companies offer to put better, or larger burners on the fixtures of the consumer, they do this not for the sake of giving a better light, but in order to increase the gas consumption. Careful observation shows that one large burner gives, with less consumption of gas, a better light than two small ones, which demonstrates the fallacy of the above misconception.

f. That gas vitiates the atmosphere more and creates more heat than either candles or oil lamps, whereas for the same amount of illumination the opposite is true.

g. That gas light is more dangerous as regards accidents, such as fire, explosions, escape or leaks of gas causing asphyxia—than other illuminants, whereas the statistics of fire underwriters and the records of hospitals show more fire and accidents caused by lamp explosions, than by gas.

h. That if in one house, owing perhaps to insufficient size of the gas service or house pipes, the pressure is low and the light accordingly poor, the gas company is able to give to this consumer more pressure if he desires it than to the neighboring houses, which is obviously impossible.

i. That gas pipes may burst from the inside gas pressure, which mistaken idea possibly arose at the time when natural gas was first supplied to towns under sometimes very heavy pressure. With gas as supplied and distributed from gas works the pressure is, comparatively speaking, very light, fluctuating from $\frac{1}{10}$ to $\frac{4}{10}$ inch of water pressure, and there is not the slightest reason for fearing that the gas pipes may burst.

k. That inasmuch as the manufactured gas emits a strong and unpleasant odor, the same odor must exist and become disseminated in the rooms, when gas is burning. It is a fact, however, sufficiently well established by experience that properly purified gas, if properly burnt, gives off no obnoxious odors.

l. That gas may and does sometimes burn inside of the gas pipes. I have met well educated and otherwise intelligent people who displayed their utter ignorance on the subject by making such statements, thus reminding me of the people, in the early days of gas lighting, of whom we are told that they put on gloves before touching the gas pipes, and of the architects who required in their specifications gas pipes to be car-

ried at a safe distance from all woodwork. The fact is, of course, that illuminating gas does not burn and will not inflame while confined in a vessel or in pipes and fittings conveying the same, because air is necessary in all cases for combustion to take place.

m. That manufacturers of gas meters and gas companies work hand in hand to defraud the consumer, whereas the fact is that gas meters are measuring machines constructed with accuracy and on scientific principles, by responsible manufacturers, and that before use all meters are tested as to their accuracy by special State meter inspectors. Therefore, whenever a consumer believes his meter to be wrong, he may have it tested, exchanged, or repaired by notifying the gas company.

n. That gas bills are made out regardless of the amount of gas consumed, which popular error has been already alluded to in speaking of the prejudices of consumers.

Much can be done to remove such popular fallacies by proper explanations given to gas consumers.. The gas companies have constant opportunities to give to their customers information and advice upon many of the matters touched upon above.

Still more good could be accomplished if gas companies would undertake to give direct advice and practical instruction on the details of domestic gas burning appliances. Some topics of interest and practical value to gas consumers are, to begin with, the gas meter, its construction and arrangement, with explanations of how to read the index of the same. If once the householder becomes familiar with reading the gas meter, misunderstandings or disputes about the gas bill would in the majority of cases be prevented. Then there is the gas piping of buildings. It has been said that a bad system of internal gas piping is the arch enemy of every gas undertaking, therefore gas companies should, in the case of all new buildings, see that architects, builders and gas fitters follow the best rules on gas piping. It would certainly lead to good results if gas companies would distribute rules and regulations on the best mode of doing gas piping, on the methods of running the distribution pipes, on the sizes of pipes, and the proper manner of test ing gas pipes. Gas companies should in this way try to exercise some supervision over the consumers' fittings, and also insist upon the employment of responsible and qualified gas fitters only. Regarding gas burners, the gas companies should remind consumers that even the best of burners wear out and that worn out burners mean a waste of gas, also that burners become obstructed and need periodical cleaning. They might, with advantage, go a step further and give to the householder information regarding improved burners, or supply the consumer either free or at a nominal charge, with the best kind of burners rather than see him at the mercy of the burner quack. Many consumers, without doubt, would welcome any judiciously thrown out hints about burners and lamps. Information about gas lamps and gas fixtures, gas globes, globe holders, shades and reflectors would also be useful, particularly a demonstration of the advantages arising to householders from the use of gas globes of clear glass with wide bottom openings, supported in shadowless triangles of thin wire.

Gas companies should explain the object and use of gas pressure regulators and of volumetric governor burners. In districts with excessive gas pressure they should teach the gas consumer the proper remedy for "blowing" burners. It is much to be regretted that, as a rule, gas companies are opposed to the use by consumers of pressure regulators of any kind, except the ordinary check burners which are notoriously unreliable, while they themselves make extended use of the best volumetric governor burners on their street lamps. The use of pressure regulators should be discouraged only where the house piping is quite insufficient in size. Much may be accomplished by employees of the gas companies giving instruction to consumers about the proper management and use of gas. Gas is wasted in houses in many ways, and children as well as servants are proverbially careless or thoughtless in the use of gas, keeping lights burning many times when not wanted. Again, the householder's attention should be called to defective gas keys, such as the "all round" keys without stop pins, which often cause escapes of gas and may lead to serious accidents. There is not a gas consumer who would not thankfully accept advice upon such points, if it were given conscientiously and in a proper manner.

Many hints may be thrown out regarding the maintenance of gas fittings, the cleaning and renewal of burners, the cleaning of chimneys and globes, the greasing and tightening of the gas keys, the refilling of the water joint in hydraulic gasaliers, and kindred subjects. The annoying and aggravating irregularities sometimes occurring in the gas supply, and the proper way to remedy each trouble, should be lucidly explained. The consumer's attention should be called to objectionable gas leaks, whether in the pipes and fittings, or in the fixture joints, or at the gas keys, or at the burners, and the remedy given. All necessary and usual precautions against danger from fire should likewise be explained and commented upon. Useful hints may be given regarding the advantage, economy and convenience of gas cooking and gas heating appliances. The revenue of a gas company will be increased where the day use of gas is encouraged. In all these matters gas consumers must be aided and guided, and gas companies should not lose the opportunity of doing this, as the continued welfare of their business depends upon it. Many a grumbling consumer may be turned into a friend of the company by timely advice, given in a discreet manner. Gas managers, gas inspectors, and likewise all gas fitters should be well informed on these topics, so as to be able to give intelligent advice to the consumer.

While there are several ways in which gas companies may educate the consumers, one of the best means consists in the arrangement by the gas company, at their office, of a general exhibition of gas apparatus. In this exhibition should be included a collection of the best gas lighting burners, also samples of governor burners, of well-shaped glass globes and shadowless globe holders, of improved modern regenerative and incandescent gas lamps, etc. A good gas pressure regulator should be shown in practical operation, likewise an exhibition meter constructed of glass, so as to show the interior construction and working mechanism of the gas meter. Finally, there should be exhibited the best examples of gas cooking ranges, of apparatus for heating water, for heating laundry irons, also gas heating stoves, incandescent fire-place heaters and terra cotta gas logs. All of these appliances should be fitted up with gas connections ready for lighting up, in order to show the public their mode of operation, and their advantages and utility.

There can be no question that a well arranged showroom, containing a judiciously selected stock of the best domestic gas appliances, must have a powerful influence in popularizing the use of gas. Manufacturers of gas apparatus should aid the gas companies in this matter, as such a display would tend to create an increased demand for improved gas appliances. In connection with such exhibitions, popular lectures might be arranged on various subjects, such as on the use of gas for lighting, on cooking by gas, with demonstrations of practical cookery, on gas heating appliances, on gas motors, and the like. The gas exhibitions would prove a useful medium for distributing to consumers tracts or pamphlets upon the advantages of gas for light and fuel and power purposes and containing just such hints and general information as the public is most in need of. A liberal dissemination of such pamphlets must result in a large reduction in the number of common complaints. It is likewise desirable that printed rules for gas piping in new buildings be circulated by gas companies amongst those who are chiefly interested, *i. e.*, architects, builders, plumbers and gas fitters.

The question is often asked if it would not be advantageous to have the gas piping in new buildings done by the gas companies. After a careful consideration of this matter, I fail to see what material advantage, if any, could be derived therefrom. Gas companies necessarily must rely just as much as other contractors doing gas piping, upon the honesty, practical skill and ability of the mechanics, and in not a few instances have I found fully as much ignorance and carelessness among gas companies' fitters as among fitters in the employment of the trade. Whether the householder gives his gas piping work to the gas company, or to a tradesman, a plumber or gas fitter—his chance for securing perfect work lies mainly in paying a fair price for the work and insisting upon the employment of only competent fitters. Here, as elsewhere, the best results may be secured by proper expert supervision.

Not a little of the ill-feeling existing between gas companies and gas consumers is due to the disrespectful treatment which consumers occasionally receive in some gas offices. Employees of gas companies, and in particular the inspectors of gas meters and those clerks in the office, who come into more frequent contact with the public, should be required to be courteous and polite in manner and speech. After all, the public have a right to demand at least the same fair treatment in a gas office which they receive by clerks or salesmen in stores in which they make the purchases of the sundry necessaries of life, and where, as a rule, they are shown that they are valued customers. Fully aware of the fact that the position of the clerks in the gas office, who receive the consumers' complaints, must often be a trying one, I still hold that the ill-temper of the clerk should never be vented upon an unoffending customer. Here, as in other lines of business, it pays to be patient, obliging and polite, and nothing is gained by showing even the slightest sign of irascibility. Customers, on the other hand, ought to bear in mind that very often the clerks and inspectors of gas companies are abused by the suspicious, the ignorant, the ill-mannered people, neces-

sarily forming a portion of the customers of a gas company, and they should therefore condone a clerk's offense of sometimes appearing gruff, impatient and uncivil.

In short, gas companies would undoubtedly be on better terms with consumers if they had not, in too many cases, disregarded their wishes. The enlightenment of the gas consumer is of importance, for even well-educated men often display a very deplorable ignorance and bias as regards the use of gas. Then the public should be taught that a gas company's business is legitimate, and that their dealings are just as honest and upright as the transactions of other business concerns. And, lastly, consumers who go to the gas company's office for advice should have confidence in the suggestions made by the company. A proper observance of what has been herein stated, would undoubtedly pave the way toward better relations between gas companies and gas consumers.

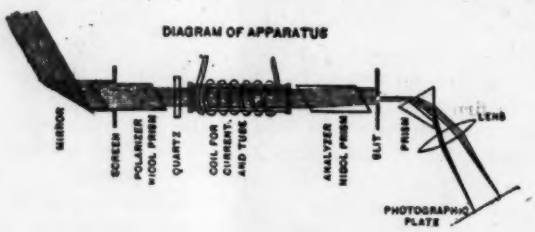
A Reliable Method of Recording Variable Current Curves.

By Dr. Albert C. Crehore.

The practical problem that has in more recent years presented itself to the electrician and physicist alike is "How shall we measure the exact current which flows in a conductor at any instant of time and record all the irregular changes to which it is subject?"

The importance of the question, since the introduction and extensive use of the alternating current, has emphasized the fact that we need a "reliable method" of measuring the instantaneous values of a variable current, which is not a "method by points," but "a method which continuously records the current."

Under "a method by points" is included any method in which the current is obtained from readings (usually of an electrostatic voltmeter) due to the charge of a condenser which may be connected in at any point of time. The essential characteristic of the method is that the current is ***supposed*** to repeat itself exactly during successive periods, or more generally when the conditions are exactly repeated. There can be no doubt that the current ***does repeat*** itself under exactly similar conditions, but can we be ***sure*** that those conditions ***are exactly repeated?*** By this method a number of points are found, the time occupied being at least several minutes, and the collection of points properly arranged is a representation of the current during as short a time as the one-hundredth of a second, perhaps. Yet this method has proved to be



a very useful and practical one, and has given us information concerning the currents and potentials of generators and transformers which is of paramount importance. Yet all will agree that this "method by points" is too limited in its application, and does not show us any sudden temporary change taking place in a current, which does not ***repeat*** itself.

Such for instance as a sudden "make," or "break," or "change" in an alternating current would not be easily shown by this method. The second method, previously designated, "***a method which continuously records the current***," is the one to which this paper more particularly refers. Under this head is included all methods which attempt to record the current by causing it, either directly or indirectly, to move a material something so that its displacement is some single valued function of the current. As an example of this method may be mentioned the well-known experiments of Froelich, in which a telephone is used, upon the disc of which is mounted a mirror that permits a beam of light to be reflected from it. Any vibration of the disc gives an angular motion to the ray of light, and this motion is in turn recorded upon a moving photographic plate. Other examples might be mentioned in illustration of this method, for instance, a wire which is deflected in a magnetic field or stream of mercury so influenced; but it will be noticed that in all of these cases an appreciable amount of ***ponderable*** matter is required to be moved backward and forward during each reversal of the current. When the current reverses hundreds of times per second, the unavoidable difficulty is introduced that the forced oscillations of this ponderable matter, no matter how small in amount, become so superimposed upon those of the current which it is desired to measure that they are inseparably mixed together; and the record does not show the true current, but the resultant vibrations of the instrument. That this is the case with the method of the telephone, above referred to, has been established beyond a doubt, it seems, by experiments conducted at Cornell University by Mr. Henry Floy. The current furnished to the telephone was carefully measured by the "method by points," and care was taken to see that the current as measured by points was the same as that used in the telephone. The vibrations of the telephone did not even approximately agree with the current as measured by well-established methods.

Bearing these points in mind, and remembering the high frequency of some of the oscillations which it is desired to record, may we not with some degree of certainty predict that any of these methods requiring the rapid motion of ponderable matter will be open to precisely the same objections which are noticed in the case of the telephone? Without answering this question, probably all will agree that the difficulty may ***certainly*** be avoided by using as a vibrator, instead of this so-called "***ponderable matter***," a vibrator that has ***no*** weight. It is to this question of finding a form of vibrator ***without weight*** that I invite your attention.

The idea of the weightless vibrator is perhaps already suggested in the beam of light. But how shall we cause a beam of light to have a change in direction simply by means of a current flowing in a circuit without the intervention of some moving material? A way of influencing a beam of light directly by an electric current (or more properly by its magnetic field) is that discovered long ago by Faraday. It is by means of the discovery of the rotation of the plane of polarization by an electric current that I propose a method of obtaining a weightless vibrator. The explanation will be made clearer by reference to diagram of apparatus (Fig. 1.) A beam of light is passed through a polarizer (Nicol prism) so that the vibrations of the beam take place in only one plane upon emergence. If it is then passed directly through an analyzer (Nicol prism) the latter may be set at such an angle as to prevent all light from passing through it, and thus produce darkness beyond the analyzer. Faraday's discovery was that, if a beam of polarized light is passed through some ***substance*** in the direction of the lines of magnetization within that substance, there is a rotation of the plane of polarization in a direction which is the same as the direction of the current required to produce such a magnetic field. The direction of rotation is unaltered, therefore, whether the light beam advances in the same or the opposite direction to the magnetization, so that a beam reflected back and forth through the substance several times has its rotation increased by equal amounts each time. If the direction of the ray of light be at right angles to the lines of magnetization there is no rotation produced.

If now the light is passed through a polarizer and then through a tube containing the substance used, around which is wound a coil of wire, and thence through the analyzer, an observer would find complete darkness upon looking through the analyzer when set in the crossed position. But if without moving the analyzer a current is sent through the coil on the tube, light appears to the observer. This is because the plane of polarization has been rotated by the current and practically the prisms are no longer crossed. Now let the analyzer be rotated while the current is still flowing, and the observer will see a series of beautiful colors through the analyzer, a different one for each position of it; but, as long as the current flows, he cannot produce darkness again by any amount of rotation of the analyzer.

This effect suggests what is known to be a fact, that the different wave-lengths composing white light are rotated by the current in different amounts, so that when the analyzer is turned to the angle corresponding to the yellow light, say, only the yellow light is prevented from passing through the analyzer. All the other rays, being rotated by different amounts, pass through the analyzer, and there being mixed together they give rise to the series of beautiful complex colors above mentioned. A different color is seen for each position of the analyzer, because in each position a different color is subtracted from white light, and the observer sees what is left or merely the complementary color. Fortunately we have substances which naturally rotate a beam of polarized light, for by means of this aid we may obviate the difficulty that the band vanishes with no current. For instance, a parallel plate cut from a crystal of quartz perpendicular to the optic axis has this property of rotating the plane of polarization. Quartz is selected for the material used because of its great transparency and high specific rotary power.

The tube upon which the coil carrying the current was wound was a glass tube of 1.4 cm. internal, and 1.8 cm. external diameter, and 70.15

cm. long. The tube was filled with carbon bisulphide, which was confined in the tube by means of two plane parallel plates of glass, each 1.3 cm. thick, fitted tightly upon the ground ends of the tube. Upon this tube was wound six layers of No. 18 double cotton copper magnet wire, occupying a length upon the tube of 61.5 cm. The wire was wound so that 100 turns occupied 12.7 cm. Thus the total number of turns, 2,900, is very large considering the size of the wire.

The light used was sunlight reflected from the mirror of the heliostat.

The Nicol prisms are two fine specimens which were obtained by Dartmouth College at a time when larger specimens could be obtained than may now easily be found. The width of the slit does not need to be very narrow. A width of a quarter to a half millimeter will do better than a narrower one, because more light is admitted to the photographic plate, and in passing through so many different substances even sunlight is rendered comparatively feeble by the time it strikes the photographic plate.

A further description of the apparatus is hardly deemed to be necessary, inasmuch as no claim is made to having obtained more than the most crude of first results, which may be the results attained by apparatus arranged in a comparatively poor manner for the end sought. Yet the results obtained seem to be so promising for the future that the subject is presented to you at this early date in the experiment, in the hope that it may soon receive an impetus from other experimenters who have better facilities than those at my disposal, and thus become a fruitful source of extending our knowledge of instantaneous current flow in conductors.

Improvements in the Manufacture of Sulphuric Acid.

By Mr. Peter S. Gilchrist.

In the *Journal of the American Chemical Society*, for November, 1893, I gave a brief outline of the Hacker and Gilchrist pipe columns for saving chamber space, quoting results which had then been obtained in actual working. I wish to follow this with results of much greater interest.

As stated previously, the pipe columns were added to a plant having large chambers, the first three being each 160 feet long, and consequently not so effective as in combination with short chambers, the best work being 17 cubic feet of chamber space per 1 pound of sulphur per 24 hours, and this with Glover and Gay-Lussac towers. The ratio of chambers has an important bearing on the amount of work done in a given space.

It has long been thought that short chambers were essential to good work, repeated experiments in Europe having demonstrated this, but there has been much tardiness in adopting them.

An observer of the chamber process notices that as the gases pass from one chamber to another a greater reaction sets in, consequently followed by an increased production of sulphuric acid. The reasons for this are obvious; the vapors strike against the surfaces of the chamber ends and the sides of the connection, causing the particles forming to interact more quickly. Again, th gases being passed through a small aperture become better mixed, and the gases are also cooled by radiation from the lead surfaces, which is an important point in manufacturing. It has been proved in chambers of 100 feet and over that after the gases have traversed 50 to 55 feet of the length the acid produced falls off considerably, so by cutting off the chamber at this point we get the maximum work from the chamber.

The important point in constructing a sulphuric acid plant is to endeavor to attain these conditions throughout the process as much as is possible, and if the mere passage of the gases from one chamber to another has such visible effects, how much more so, when these conditions are very greatly improved on, as is the case when using pipe columns.

The large, moist surfaces presented by the numerous pipes upon which the gases impinge, the thorough mixing which the gases receive by coming in contact with each successive layer of pipes, and lastly, the heat generated by the reaction, consequent upon the mixing, being carried off by the cold air passing through the pipes, are conducive to a very rapid formation of sulphuric acid.

The cyclone of last August having destroyed the acid chambers of the Darlington Phosphate Company, of Darlington, S. C., I was asked to superintend the rebuilding of the same.

The original plant consisted of three chambers, having a total capacity of 129,500 cubic feet, with a small coke tower in the rear, using Johnson's mechanical fines furnaces, with no niter recovery, making at the outside 11 tons of 50° Beaume acid per day.

The present plant consists of four small chambers, the first only 15 feet long, its object being to catch the dust, the second 60 feet, the third 50 feet, and the fourth 43 feet, having a total capacity of 100,800 cubic feet, with coke tower in the rear, using the same furnaces, and no niter recovery.

Between each chamber there is a pipe column averaging 3′.10″ by 3′.5″, and 13′.6″ high, between the last chamber and the coke tower, a small pipe case 3′.0″ by 1′.10″, and 6′.0″ long.

The average work for the last 81 days is as follows: Pyrites burned per day, 14,304 pounds, averaging 44.6 per cent. sulphur, two-thirds being Virginian ore, and one-third Spanish, actually yielding 43 per cent. sulphur. This is an equivalent of 6,153 pounds of sulphur, being 16.38 cubic feet of chamber space per 1 pound of sulphur per 24 hours, and in the cooler months was under 15 cubic feet.

The average yield of acid for this period was 14 tons of 50° Beaume acid per day, or 4.552 pounds of 50° acid, per 1 pound of sulphur, per 24 hours.

As this means an increase over the total chamber area of $\frac{7}{16}$ of an inch, calculated as 50° acid, one can readily appreciate the amount of work done in the system.

The average temperatures of the chambers were as follows:

No. of Chamber.	Front.	Back.
1	220° F.	222° F.
2	178° "	176° "
3	156° "	154° "
4	123° "	102° "

Atmospheric temperature, 73° F. Average oxygen in the escape gases, 6.6 per cent. Average acidity in the escape gases, 0.81 grain sulphuric anhydride per cubic foot.

The result of the application of the pipe columns over the original plant is as follows: Reduction in the size of the chambers, 21.84 per

Sections of Pipes.

cent. Increase in the yield of sulphuric acid made, 28.18 per cent., equal to a total increase of 50.02 per cent.

Another plant is being completed in Savannah, Ga., having short chambers, pipe columns, Glover, and Gay-Lussac towers, which will, doubtless, confirm more fully the advantages of the pipe columns.

The construction of the pipe columns has been much improved, more especially in connection with the sections of the pipes used. The exteriors are made so as to enable the greatest amount of mixing to be got from a minimum surface of contact.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

The Oswegatchie Light and Power Company, to furnish gas and electricity for public and private uses in the towns of Gouverneur, Edwards, Fowler and other towns in St. Lawrence county, N. Y., has been incorporated, with a capital stock of $60,000. The Directors are H. Walter Webb and A. G. Paine, of New York City; William J. Arkell, Canajoharie; and Augustus L. McCrea, Jr., and A. J. McDonald, of Gouverneur.

The Capital Gas and Electric Light Company, of Frankfort, Ky., renewed this year its offer of last summer of three prizes in gold coin to the housekeepers who, after open competition, were adjudged to have mixed and baked the best specimens of the named cakes: White pound cake—prize, $20 in gold; angel food cake, $15 in gold; layer cake, $10 in gold. The main and governing condition was that the cooking should be done on a gas stove and that time would also be considered as a determining factor; in other words, that if two specimens seemed to be equal in respect of flavor, soundness and appearance, the one cooked in the shortest time would receive the award. The judges (three in number) were selected from the families of three prominent residents, and their task was an extremely difficult one, for no less than 43 specimens of cake were submitted by as many competitors. The palm of superiority was, however, eventually awarded as follows: White pound cake, Mrs. W. S. Johnson; angel food cake, Mrs. Thos. B. Rodman; layer cake, Mrs. A. L. Franklin. The Company is quite well satisfied

at the outcome of the competition, in that several orders for gas ranges have been obtained.

We understand that the Goshen (N. Y.) Gas Company's properties have been purchased by a syndicate, of whom Mr. Charles F. Hunt is the leading man. The purchasers say they will remodel the plant—any change whatever would improve it—and reduce the selling rate, with a view to encourage the use of gas for purposes other than lighting.

The following letter explains itself :

New York, July 6, 1894.

Mr. William Cox, Stapleton, N. Y.: The "Gas Flow Computer" which I ordered by mail came duly to hand. I am very much pleased with it and think it should be in the hands of every member of our profession who has to do with the problems arising in connection with main laying. I have not as yet had an opportunity to test its accurateness practically, but in a number of calculations which I have made for the purpose, I find it works out perfectly with the accepted formulas. You are certainly deserving of all success in introducing it.—Yours truly, W. H. Bradley, Chief Engineer Consolidated Gas Co.

The United States Projectile Company, of Brooklyn, N. Y., is making extensive additions to its machine shop, and has placed the contract for this work with the Berlin Iron Bridge Company, of East Berlin, Conn.

At the annual meeting of the Milwaukee Gas Light Company several changes were made in the executive management. Mr. F.W. Montgomery, First Vice-President of the Company, is no longer connected with it in any capacity, and Mr. A. E. Smith, who was Secretary, is now a member of the Board of Directors. The Directors chosen were: E. McMillin, B. M. Weil, S. M. Green, H. C. Payne, F. G. Bigelow, A. E. Smith, W. Becker, J. P. Murphy and E. G. Cowdery. Messrs. Bigelow and Becker are new men, Mr. Bigelow succeeding F.W. Montgomery, and Mr. Becker took the place of Mr. B. K. Miller, Sr. The officers chosen were : President, Emerson McMillin ; First Vice-President, B. M. Weil ; Second Vice-President, S. M. Green; Secretary and Treasurer, J. J. Glass ; Assistant Secretary, Emil Hasse ; General Manager, E. G. Cowdery.

The gas works proposed for Snohomish, Wash., will be constructed, a franchise for the same having been granted to a Mr. Williams, who estimates that $50,000 will be sufficient to build the works and pipe the city. Snohomish has for some time back supported fairly well an electric lighting plant.

The Attleboro (Mass.) Gas Company has moved into its new office quarters on Dunham street, and the change is sure to be appreciated by its customers.

The officers chosen by the Louisville (Ky.) Gas Light Company are: Directors, J. M. Atherton, Harry Bishop, A. H. Barret, J. B. Speed and George W. Morris ; President, George W. Morris ; Vice-President, A. H. Barret ; Treasurer, W. P. Lee ; Secretary, E. S. Porter.

In our last issue we gave a brief summary of the decision of the Board of Gas and Electric Light Commissioners in the case of certain consumers of gas in the city of Haverhill, Mass., against the local Gas Company, and now we are enabled to give the full text of the Commissioners' opinion : "The Haverhill Gas Light Company was organized in 1853, with a capital stock of $45,000, in 900 shares, of a par value of $50 per share. This capital was in 1858 increased to $50,000, and in 1871 to $75,000. It was all paid up in cash. Haverhill has grown very rapidly ; the population in 1860 was 9,935 ; in 1870, 15,092 ; in 1880, 18,472. The Gas Light Company has, since 1871, supplied this increasing population without any increase of capital stock, using its earnings to provide the necessary plant and mains, paying out, between January 1, 1887, and January 1, 1894 :

For laying pipes and mains.....	$73,796 56
" constructing new holder.....	52,026 18
" constructing water gas plant.....	29,756 78
" land.....	7,500 00
Total.....	$163,079 52

or an average of over $23,000 a year. It is by such expenditure upon plant, without an increase of capital, that the consumers of to-day are enabled to purchase gas at the present rate, $1.40 per 1,000 cubic feet. The consumer for the time being of any well-managed quasi-public corporation gets advantages from the payments made to the Company by the consumers of the past. The consumers of the future should therefore be regarded by a board of control and enough should be paid by the present consumers to provide for the natural growth of the community. Everything which the Company under discussion has taken in the past from its customers, except the cost of manufacture, including regular dividends upon its capital, is to-day existent and used for the benefit of its consumers. The stockholders from all this increase receive only the practical guaranty of a 10 per cent. dividend. It was admitted at the hearings that the amount paid out in dividends, $7,500, was moderate and should not be lessened. The beneficial operation of this accumulation of earnings to the consumers is shown by the fact that in 1855 gas in Haverhill was sold for $4 per 1,000 cubic feet, and that to-day, by gradual reductions, it is sold at $1.40. Before November, 1891, the Company manufactured coal gas ; it then made a mixed gas until 1893. Since then it has manufactured water gas. In the year ending June 30, 1882, 15,766,100 cubic feet of gas were sold, at $2.30 per 1,000, and in the year ending June 30, 1893, 59,731,100 cubic feet were sold at $1.40. These reductions, from 1882 down to 1889, took place at intervals of two years or less. There has been no reduction since the last date. One large consumer has, since 1887, paid $1.25 per 1,000 feet, and the city, for the last fiscal year, paid $5,275.77 for 4,120,100 cubic feet of gas. On January 1, 1888, there were 1,647 meters in use, and on January 1, 1894, there were 2,981 meters in use. It is apparent from the above statements that the community has been well served by this Company, and its honorable record calls for great commendation ; and the only question before this Board is whether the Company is in a position to give its present consumers the benefit of a further reduction in price. On September 7 last, its capital was $75,000, it owed $41,669.04, and it has an apparent surplus of $131,929.77. Its assets were $248,598.81. Of all these assets only about $22,000 were quick. Its net income above expenses and dividends has, since the last reduction, steadily increased, and the last fiscal year showed that its consumers were that year paying for gas an amount which exceeded, by a considerable sum, the average expenditure upon construction noted above. In other words, the time seems to have arrived when the Company, pursuing the same policy that it has in the past, should make a reduction in the price of its gas. Therefore the Board recommends that on and after July 1, 1894, the net price charged by the Haverhill Gas Light Company for gas should not exceed $1.30 per 1,000 cubic feet.—John T. Wheelwright, Chairman."

Shortly after the Haverhill Company received a copy of the Commissioner's decision a meeting of its Board of Directors was held, at which the following resolution was unanimously adopted :

Voted, That in accordance with the recommendation of the Board of Gas and Electric Light Commissioners, contained in its decision, dated June 27th, 1894, the net price of gas supplied on and after July 1, 1894, to consumers of the Haverhill Gas Light Company, shall be $1.30 per 1,000 cubic feet, if paid on or before the 25th day of the month in which the bill is presented, and $1.40 if paid after said 25th day.

At the semi-annual meeting of the Directors of the Lebanon (Pa.) Gas Company a dividend of 4 per cent. on the stock was declared.

Alonzo Barklay, a tobacconist of Wheeling, W. Va., who was arrested some days ago, is charged with the stealing gas from the City Gas Works. His method was the usual one of bye-passing the meter. It is said that the authorities have also secured evidence of similar thefts by other residents of the city, some of the alleged culprits being prominent business men.

The Pittsburg (Pa.) *Despatch* says that Messrs. F. P. Wellman (Philadelphia) and George Goetz (Milwaukee), experts employed by the Philadelphia Natural Gas Company, are now in Europe making investigations in regard to the manufacture of fuel gas. On their investigations and subsequent report will depend the extensiveness and progress of the fuel gas plant, which the Company proposes eventually to erect on Brunot's Island. The experts are well known engineers, and before leaving for Europe made investigation in this country on the subject of fuel gas. The Company proposes to secure all possible information bearing on fuel gas before it makes final arrangements in a matter which means so much to it and the public. The outlook for a supply of natural gas is much better now than when the project for a plant for the manufactured article was first started, but the Company does not propose to take any risks, and wishes to be ready if the natural gas supply should happen to give out or be so reduced that a substitute would be necessary.

The United Electric Light and Power Company, of New York city, is putting up a new switchboard building, which will be covered with

an iron roof and the Berlin Iron Bridge Company's patent anti-condensation corrugated iron roof covering.

At the annual meeting of the Burlington (Vt.) Gas Light Company the following Board of Directors was elected: B. B. Smalley, F. H. Wells, A. G. Pierce, U. A. Woodbury, J. S. Pierson, R. G. Severson and F. H. Parker.

The Hudson (Mass.) Electric Light Company has sued the town of Hudson for $18,000 damages for failure of the town to purchase the electric lighting plant, after having voted twice in open town meeting to accept the provisions of an act allowing towns to own and operate electric light and gas plants. The papers were served last month, and are returnable on August 1st. The Company claims damages from the fact that the action of the town was sufficient to deter several parties from either purchasing the plant outright or furnishing additional capital to increase its facilities. It is further claimed the conditions of the suit and the relations of the Company to the town are similar to, if not identical with, those of the town of Wakefield and the electric light company of that place, the recent decision of the court being that the town of Wakefield should purchase the plant at a considerable advance on the original price.

The proprietors of the East Saginaw (Mich.) Gas Light Company have closed a contract with the United Gas Improvement Company for a set of the latter Company's standard Lowe water gas apparatus, the set to have a capacity of 200,000 cubic feet per diem. The Saginaw contract also includes considerable auxiliary work in the way of iron flooring, iron roofs, storage oil tanks, etc.

The Evansville (Ind.) Gas and Electric Light Company has agreed to light the local court house and jail with gas at the rate of 75 cents per 1,000 cubic feet.

The city's answer to the petition of the Montreal Gas Company for an injunction to restrain the authorities from permitting the Consumers Gas Company to supply gas to citizens before May 1, 1895, which was filed on the 6th inst., is appended:

"1.—The litigation between the plaintiff and the Consumers Gas Company is simply a question of damages, the extent of which is not known, and in which the city has no interest whatever; in fact, to supply gas to the citizens is not prohibited by law, and the city is not authorized by its charter to restain or hinder the sale of gas by anyone; the Companies have no monopoly or exclusive privilege to manufacture or sell gas in the city of Montreal, and no citizen or ratepayer is obliged to secure his supply of gas from the said Companies no more than from the city itself. Therefore, it is alleged, the contract between petitioner and the city is simply a permit to excavate in the streets of the city, and to lay pipes, with the obligation to manufacture gas, in order to furnish a supply to citizens. The city did not violate this contract when it allowed the Consumers Gas Company to do the same as the Montreal Gas Company, since it is expressly stipulated in the contract that in the two years immediately preceding the expiration of the said contract, the city may permit any person or company to excavate in the streets and to lay pipes, in order to be prepared to execute a new gas contract. This is simply what was done in the premises, and therefore the Consumers Gas Company is simply within the limits of the powers and privileges conferred by law, and the city cannot restrain the Company from exercising its rights, nor can it be compelled by injunction to restrain the Company.

"2.—If the petitioner has suffered any damage by any act of the Consumers Gas Company, which was not authorized by the city, the petitioner may have direct recourse against the Consumers Gas Company, the same as it would have against any third party who would cause any damage, and it would cause a writ of mandamus or a writ of injunction to issue against such parties, according to circumstances.

"3.—The Consumers Gas Company is authorized by its charter to manufacture and sell gas to the public, and to construct appliances for that purpose, without the authorization of the city, and the city would therefore not be in a position to exercise its rights in warranty against the Company, if the writ of injunction were allowed to issue.

"4.—By a contract, made on the 22d December, 1893, before Mtre. O. Marin, notary, the city gave to John Coates & Co., now the Consumers Gas Company, the privilege 'to do all necessary works and to lay gas pipes in the streets, lanes, and public places of the city of Montreal, and to commence the construction of said works and the laying of said pipes in the streets, lanes, and public places of the city, and to continue the same diligently, so that everything be ready to supply gas in accordance with the said contract.' The object of this contract was to obtain for the citizens and the ratepayers a considerable reduction in the price of gas. This contract was made conformably to the powers conferred on the city by its charter, and no privileges or anterior agreements made with the petitioner were violated thereby; neither has a monopoly nor exclusive privilege to supply gas been created.

"5.—The temporary writ of injunction is allowed to issue only in cases of great urgency, and only in cases for which the law grants no other remedy. In the premises there is no urgency; on the contrary, citizens who are supplied with gas by the Consumers Gas Company would be deprived of it to their detriment and the petitioner could not benefit by this, as the citizens are not obliged to take gas from them, or even to take any at all. Moreover, the parties have their action in damages, if there has been any violation of the rights of the petitioner, and vice versa."

Another contract just awarded the United Gas Improvement Company is that given it by the Kalamazoo (Mich.) Gas Company. The contract calls for a standard plant of the improved Lowe type, rated to produce 200,000 cubic feet every 24 hours. This contract was awarded without competition. While on this subject we might also mention that the quarter-million per diem plant recently completed by the U. G. I. Company for the New Orleans (La.) Gas Light Company was so satisfactory to its purchasers that the latter accepted the plant after a test only running one-third of the time stipulated in the bond.

The Goodwin Meter Company has been authorized to construct a new 14-foot station meter, to be set up in the 25th Ward station of the Philadelphia Municipal Gas Works. The Goodwin Company has just furnished a meter of the size above named for the Point Breeze station of the Philadelphia works.

On June 29th the new works of the West Side Gas Company, of Kingston, were put in operation, and gas was turned into the mains put down for the purpose of lighting up the shops, homes, etc., of the residents of Kingston, Forty Fort and other boroughs on the line of the north branch of the Susquehanna river, just opposite the busy city of Wilkes-Barre. Under the able supervision of Mr. L. L. Merrifield, Chief Engineer of the Economical Gas Apparatus Construction Company, of Toronto, everything passed off without a hitch. The apparatus is of the latest improved Lowe type, as shown in the Merrifield-Westcott-Pearson setting. The Economical Company also had the contract for the holder and steel tank, purifiers, center-seal and yard connections, as well as for the complete generating apparatus, including floor engine, etc. Mr. A. J. Root, who had the management of the construction work on behalf of the Gas Company, was very much in evidence on the day of the "opening," having provided a luncheon for the Directors and the builders which was heartily enjoyed.

Coal vs. Petroleum.

An English authority makes the following comparison of the relative values of the named coals and petroleum:

Durham coke, containing 94 per cent. of carbon, contains 13,640 heat units, and requires nearly 11 pounds of air for complete combustion, the rise in temperature being 4,877° F., the maximum amount of water evaporated being 14.12 pounds for each pound of coke. A very good grade of bituminous coal, containing more than 81 per cent. of carbon, contains 14,143 heat units, requires 11 pounds of air for complete combustion, the rise in temperature is 4,830° F., and the maximum amount of water evaporated is nearly 15 to 1. Illuminating gas, containing 61 per cent. of carbon, contains 20,800 heat units, requiring nearly 16 pounds of air for the combustion of each pound of gas, the rise in temperature is 4,567° F., and each pound of it will evaporate more than 21 pounds of water. Oak wood when kiln dried contains about 50 per cent. of carbon, has 7,713 heat units per pound of wood, requiring six times its own weight of air for its combustion, giving a rise in temperature of 4,287° F., and each pound of it will evaporate 8 pounds of water. Wet and green sawdust, containing 45 per cent. of wood and 55 per cent. of moisture, develops 2,916 heat units, giving a rise in temperature of 2,245° F., and will evaporate 4 pounds of water for each pound of wood in the fuel.

A fair specimen of petroleum contains 85 per cent. of carbon, developing 20,360 heat units, requiring 15 pounds of air for the combustion of 1 pound of oil, giving a rise in temperature of 4,900° F., and each pound of oil will evaporate 21.5 pounds of water. Good authorities give data which show that in actual use 1 pound of petroleum will evaporate from 25 to 50 per cent. more water than anthracite, and from 60 to 100 per cent. more than bituminous coal. If petroleum were much more bulky than coal an objection might be found to it for some places; but it is not, for while a ton of coal requires from 40 to 45 cubic feet of space, a ton of petroleum occupies very much less. Another thing in favor of the oil is that, while coal contains from 3 to 15 per cent. of ash, the petroleum leaves practically no ashes behind it.

THE AMERICAN GAS LIGHT JOURNAL

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PROPRIETORS.

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NEW YORK.—AMERICAN NEWS Co., 39 and 41 Chambers Street
Germany.—B. WESTERMANN & Co., of New York.

MONDAY, JULY 16, 1894.

The Market for Gas Securities.

Weakness was the ruling feature of the quotations for Consolidated during the week, the figures for to-day (Friday) being 125½ to 127. It seems to us that there has been a systematic selling out of some prominent interest in this Company, which liquidation has been carried on for perhaps four months or more. Whether so or not, the natural tendency of the shares is downward, and it would not surprise us to see Consolidated sell at 120 before the summer is over. Other city shares are dull and uneven. The Brooklyn war is still being fought, but in rather quiet manner, although the Nassau Company is going on with its piping. Shares, so far as quotations go, are up to prices that seem far beyond their worth, but still they are firmly held. Chicago gas, on account of the unsettled condition of affairs in the Windy City, sold down sharply during the week, but to-day's figures for it—75⅛ to 75¼, ex-div.—show that it will not be long before it will assume its normal level. It ought to reach 90 before Christmas. Consolidated, of Baltimore, is again much sought after, 65 being freely offered for it. Consumers, of Jersey City, is a trifle weaker, the quotations being 56 to 59, ex-div.

Mirror Experiments.

Some interesting experiments with a rectangular glass prism are described, says *Nature*, by W. C. Rontgen in *Wiedemann's Annalen*. Those who have tried looking at themselves as reflected by two mirrors placed at right angles to each other, will remember the amusing effect created by the image, contrary to the usual reflection in a mirror, not being reversed right and left. We can see ourselves "as others see us," also, by looking straight at the surface subtending the right angle of a rectangular prism. Herr Rontgen observes that in no case is the pupil divided into two equal parts by the faintly visible edge of the prism. This is an illustration of the angle between the line of vision and the axis of the eye, which is different in different people. Rectangular prisms can be easily tested for correctness of the angle by observing whether the two images of the cross wires in a telescope, as seen in the two surfaces, coincide. The same test would tell us whether two mirrors are exactly at right angles—a fact which might be usefully applied for testing instruments like Gauss' heliotrope. Such a pair of mirrors, or a rectangular glass prism, give rise to another peculiar phenomenon. If they are rotated about the axis of vision, the image rotates in the same direction with twice the speed. If, therefore, the object, say a cardboard disk with writing on it, rotates twice as quickly as the mirrors or prism, it will appear to stand still. This might be applied to investigate the effects produced upon bodies by rapid rotation. Another peculiarity is that such an instrument will reflect rays falling upon the hypotenuse at any angle up to 45° to the same spot. By rotating such a prism about a line at right angles to its edge and to its hypotenuse the author was enabled to reflect the light from an electric lamp through a distance of 1 km. with ease and certainty.

Gas Stocks.

Quotations by Geo. W. Close, Broker and Dealer in Gas Stocks.

16 WALL ST., NEW YORK CITY.

JULY 16.

☞ All communications will receive particular attention.
☞ The following quotations are based on the par value of $100 per share.

	Capital.	Par.	Bid	Asked
Consolidated	$35,430,000	100	125½	127
Central	500,000	50	100	—
" Scrip	220,000	—	100	—
Equitable	4,000,000	100	185	188
" Bonds	1,000,000	—	106	108
Metropolitan, Bonds	658,000	—	108	112
Mutual	3,500,000	100	151	—
" Bonds	1,500,000	—	100	102
Municipal, Bonds	750,000		—	—
Northern		50	80	95
" Bonds	150,000	—	—	100
Richmond Co., S. I.	348,650	50	50	—
" Bonds	100,000	—	—	—
Standard Gas Co—				
Common Stock	5,000,000	100	25	30
Preferred	5,000,000	100	80	—
Yonkers		50	112	—
Gas Co's of Brooklyn.				
Brooklyn	2,000,000	25	105	—
Citizens	1,200,000	20	50	—
" S. F. Bonds	320,000	1000	—	101
Equity Gas Light Co.	2,000,000	100	—	—
Bonds	1,000,000	—	—	—
Fulton Municipal	3,000,000	100	130	132
" Bonds	300,000		103	—
Peoples	1,000,000	10	—	70
" Bonds (7's)	368,000	—	100	—
" " (6's)	94,000	—	98	100
Metropolitan	870,000	100	132	136
" Bonds (5's)	70,000	—	100	—
Nassau	1,000,000	25	—	155
" Ctfs	700,000	1000	99	100
Williamsburgh	1,000,000	50	138	145
" Bonds	1,000,000	—	107	110
Out of Town Gas Companies.				
Bay State Gas Co.—				
Stock	5,000,000	50	14½	15½
Income Bonds	2,000,000	1000	60	—
Boston United Gas Co.—				
1st Series S.F. Trust	7,000,000	1000	78	—
2d " " "	3,000,000	1000	57	58
Buffalo Mutual, N. Y.	750,000	100	120	—
" Bonds	200,000	1000	95	100
Citizens, Newark	1,000,000	50	155	160
Chicago Gas Company.	25,000,000	100	75⅝	75¾
Chicago Gas Light & Coke Co.—				
G't'd Gold Bonds	7,650,000	1000	81⅛	81½
Consumers Gas Light Co., Jersey City	2,000,000	100	56	59x
Bonds	600,000	1000	92	—
Cincinnati G. & C. Co.	7,000,000	100	192	—
Consumers Toronto	1,600,000	50	184½	187
Central, S. F., Cal			90	100
Capital, Sacramento, Cal			—	55
Consolidated, Balt	11,000,000	100	65	65½
" Bonds	6,400,000		107	107½
Citizens Gas Lt. Co., Rochester, N. Y.	500,000	—	85	101
Bonds	250,000		—	—
Detroit Gas Co.—				
Con. Bonds			60	—
East River Gas Co., Long Island City	1,000,000	100	—	—
Bonds	500,000	100	89¼	—
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1000	—	101
Hartford, Conn	750,000	25	120	128
Jersey City	750,000	20	190	200
Louisville, Ky	2,570,000	50	125	130
Laclede Gas Light Co. St. Louis, Mo.—				
Common Stock	7,500,000	100	16	17
Preferred "	2,500,000	100	66¼	67
Bonds	9,034,400	1000	86½	87
Little Falls N. Y.	50,000	100	—	100
" Bonds	25,000	—	100	103
Montreal, Canada	2,000,000	100	200	208
New Haven, Conn		25	200	—
Oakland, Cal			42⅝	43
People's Gas and Coke Co., Chicago—				
1st Mortgage	2,100,000	1000	—	108
2d "	2,500,000	1000	104	105
Peoples, Jersey City	500,000	—	175	185
" " Bonds			—	—
Paterson, N. J		25	99	102
Rochester, N. Y		50	80	85
Preferred			90	95
Bonds			90	95
Syracuse, N. Y	500,000	25	—	—
San Francisco Gas Co. San Francisco, Cal.	10,000,000	100	71	71½
Washington, D. C	2,000,000	20	240	—
Wilmington, Del	500,000	50	180	182

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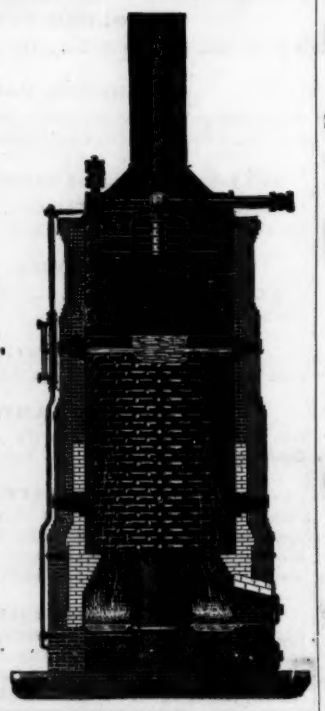

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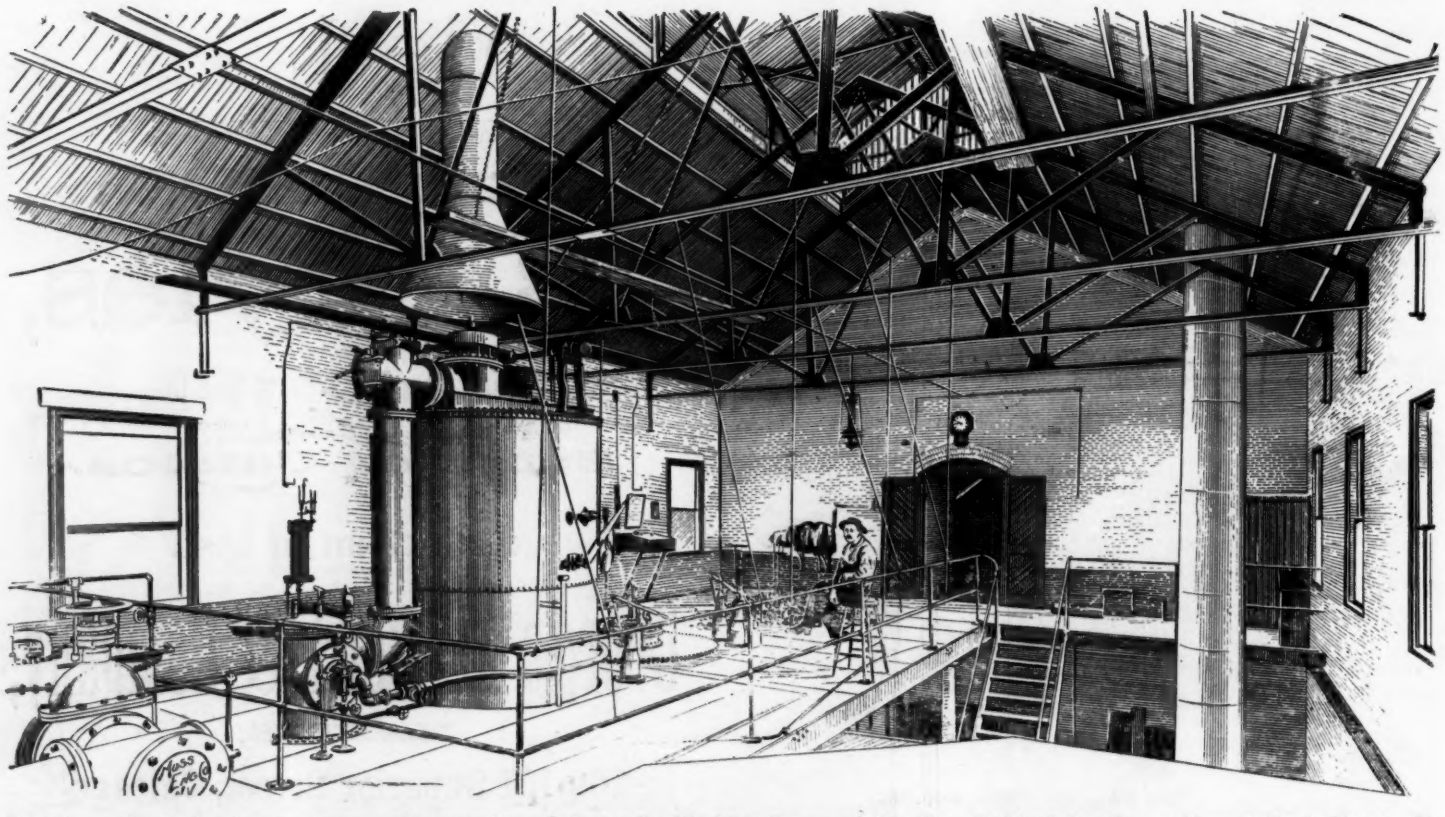

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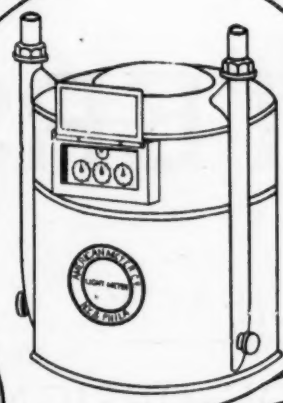

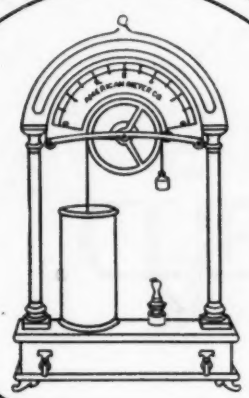

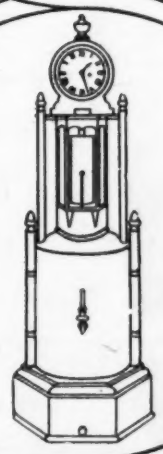

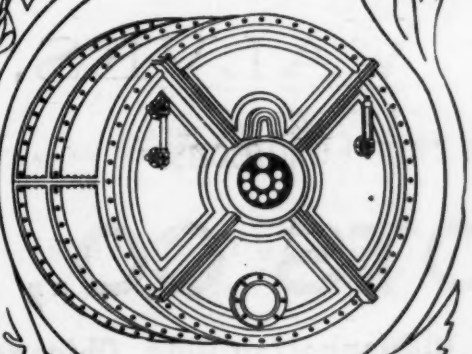

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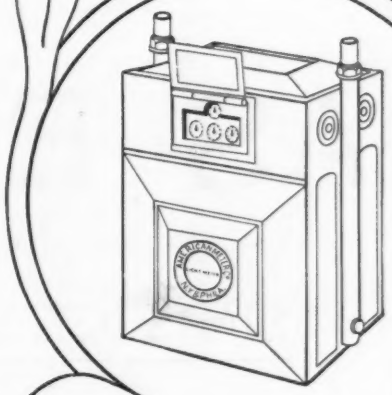
PUBLIC LIGHTING TABLE.

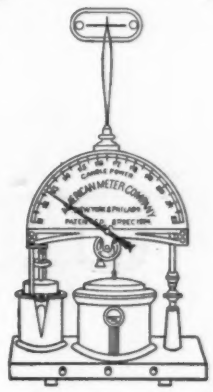
JULY, 1894.

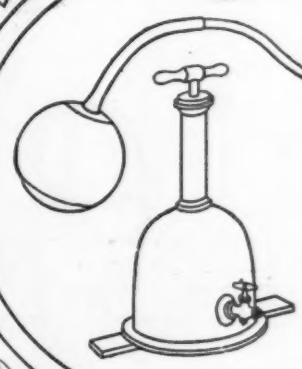
Day of Week.	Date.	Table No. 1. Following the Moon. Light.	Table No. 1. Following the Moon. Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Table No. 2. New York City. All Night Lighting. Extinguish.
				P.M.	A.M.
Sun.	1	8.00 PM	3.40 AM	7.30	3.15
Mon.	2	8.00	3.40	7.30	3.15
Tue.	3	8.00 NM	3.40	7.30	3.15
Wed.	4	8.00	3.40	7.30	3.15
Thu.	5	8.00	3.40	7.30	3.15
Fri.	6	8.00	3.40	7.30	3.15
Sat.	7	8.00	3.40	7.30	3.15
Sun.	8	10.10	3.40	7.30	3.15
Mon.	9	10.30 FQ	3.40	7.30	3.15
Tue.	10	10.50	3.40	7.30	3.15
Wed.	11	11.20	3.40	7.30	3.15
Thu.	12	11.50	3.40	7.30	3.15
Fri.	13	12.30 AM	3.40	7.30	3.15
Sat.	14	1.10	3.40	7.30	3.15
Sun.	15	2.00	3.40	7.30	3.15
Mon.	16	No L.	No L.	7.20	3.15
Tue.	17	No L. FM	No L.	7.20	3.15
Wed.	18	No L.	No L.	7.20	3.15
Thu.	19	8.00 PM	9.50 PM	7.20	3.15
Fri.	20	7.50	10.10	7.20	3.15
Sat.	21	7.50	10.30	7.20	3.15
Sun.	22	7.50	10.50	7.20	3.15
Mon.	23	7.50	11.10	7.20	3.15
Tue.	24	7.50	11.40	7.20	3.15
Wed.	25	7.50 LQ	12.00	7.20	3.15
Thu.	26	7.50	12.30 AM	7.20	3.15
Fri.	27	7.50	1.10	7.20	3.15
Sat.	28	7.50	2.00	7.20	3.15
Sun.	29	7.50	4.00	7.20	3.15
Mon.	30	7.50	4.00	7.10	3.30
Tue.	31	7.50	4.00	7.10	3.30

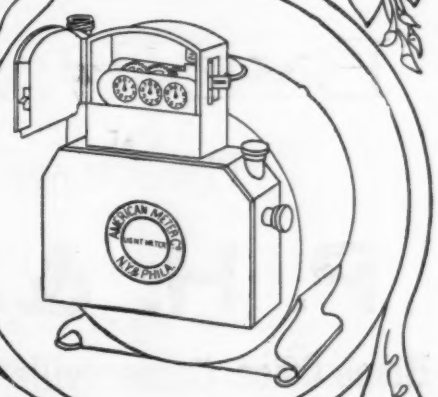
TOTAL HOURS LIGHTING DURING 1894.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	244.10	January	423.20
February	195.30	February	355.25
March	206.20	March	355.35
April	169.40	April	298.50
May	162.10	May	264.50
June	135.40	June	234.25
July	146.30	July	243.45
August	162.20	August	280.25
September	174.10	September	321.15
October	211.20	October	374.30
November	221.00	November	401.40
December	245.30	December	433.45
Total	2274.20	Total	3987.45









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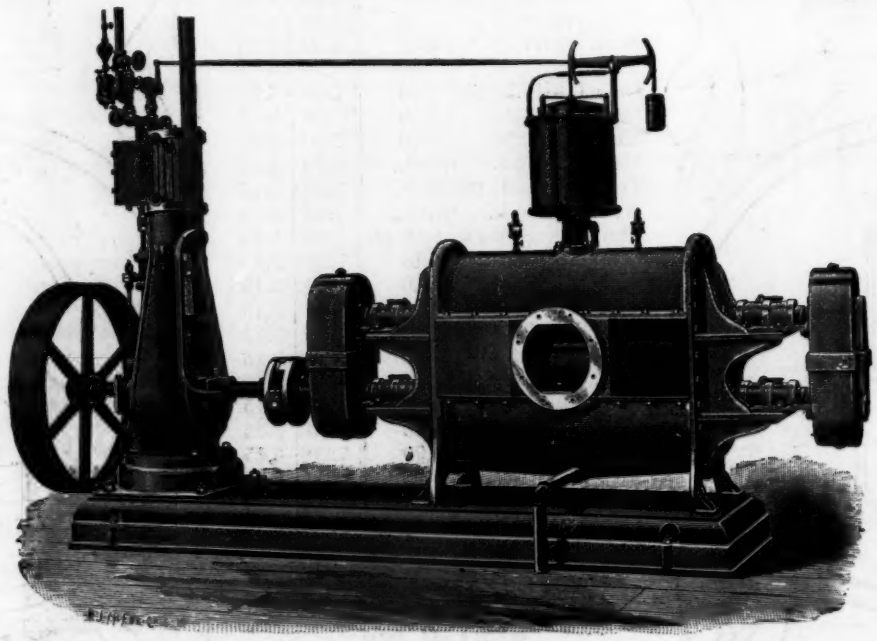

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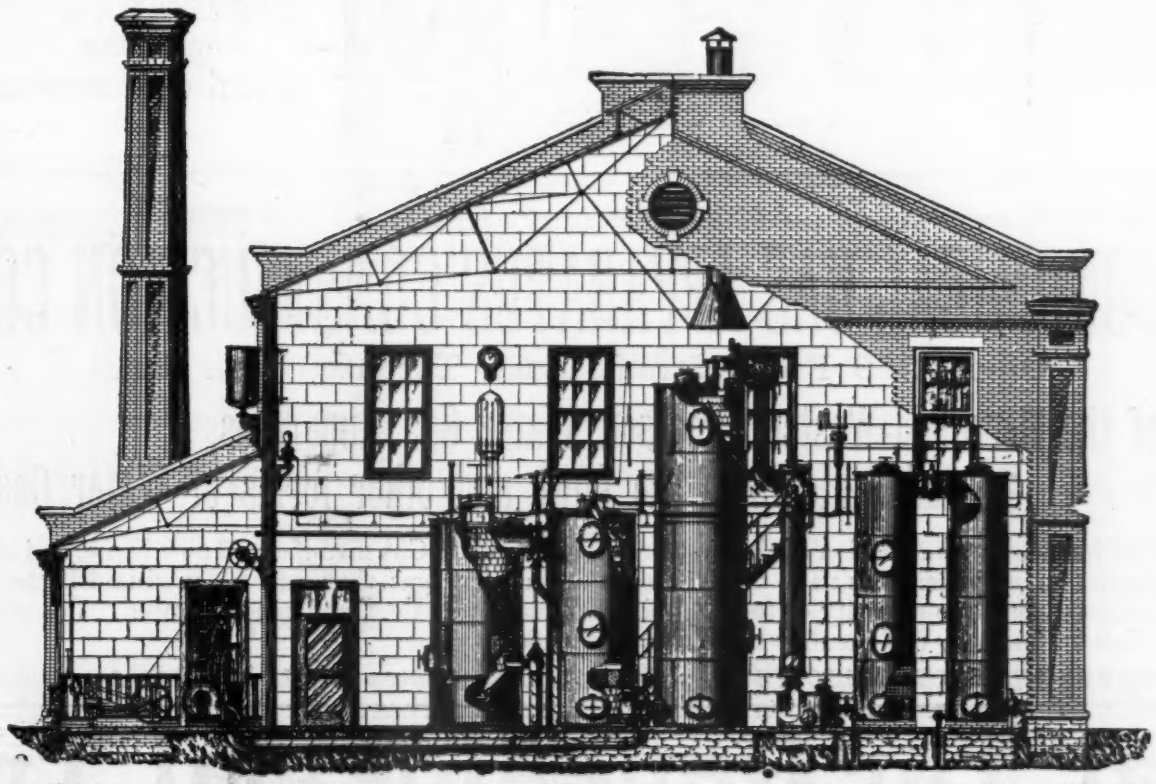

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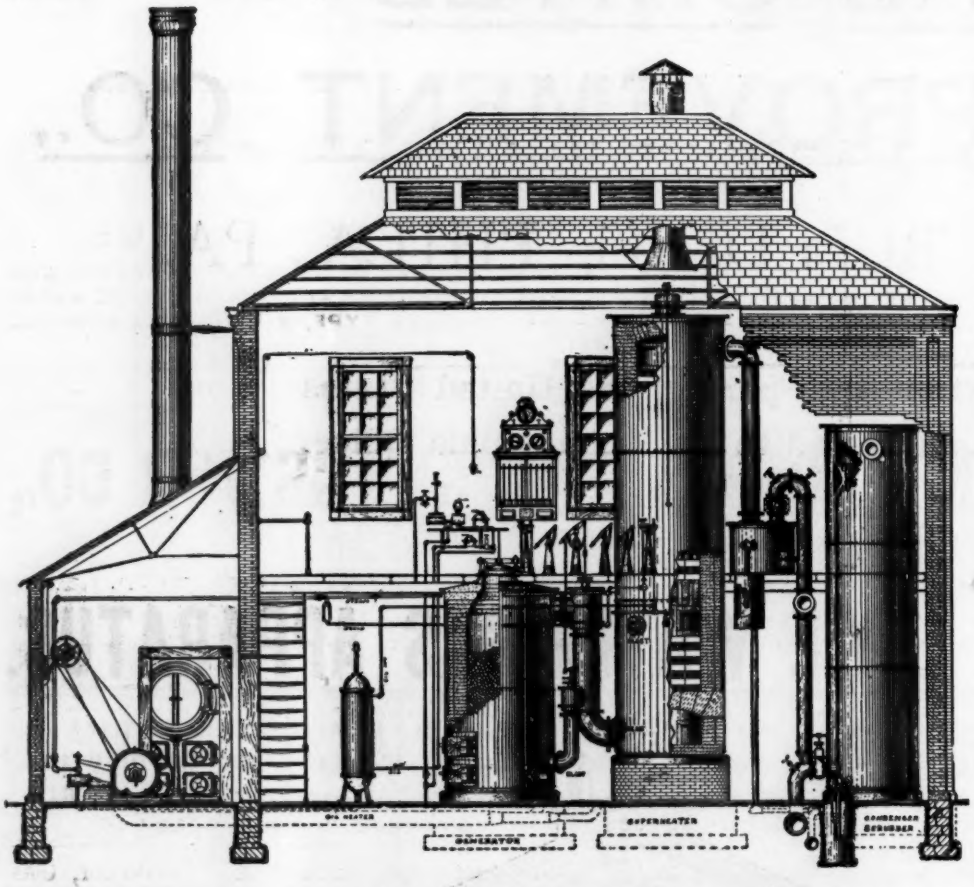

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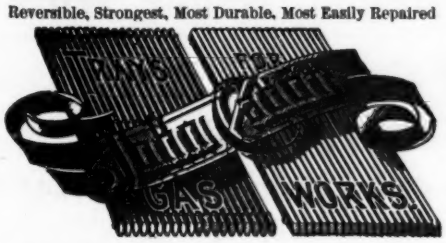

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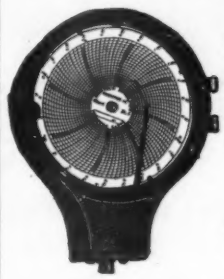

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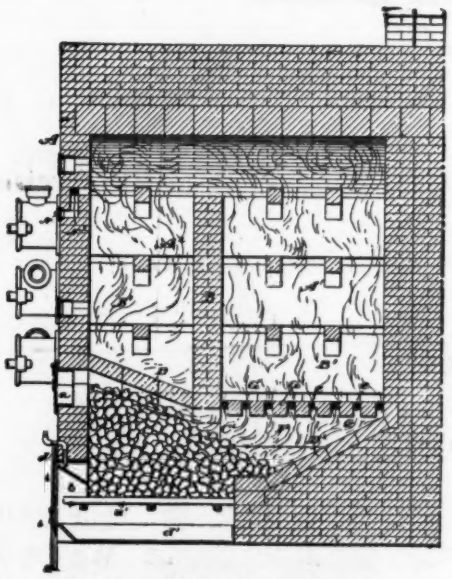

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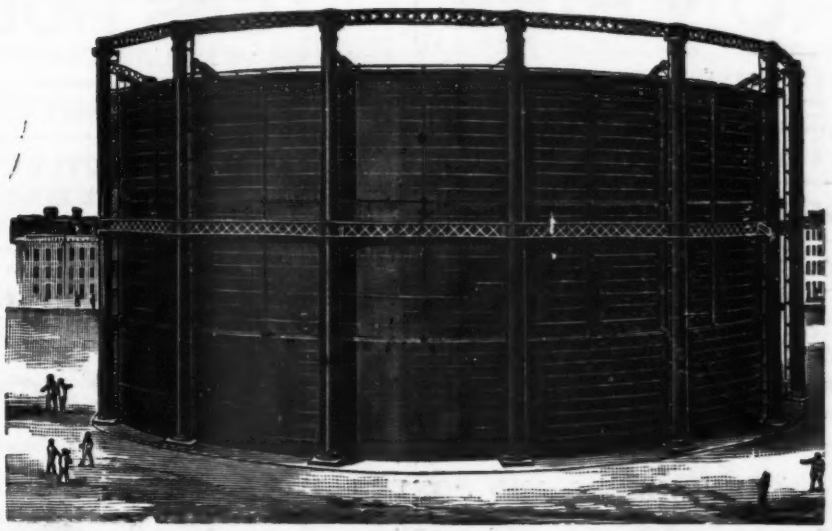

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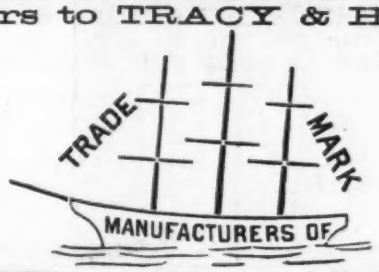

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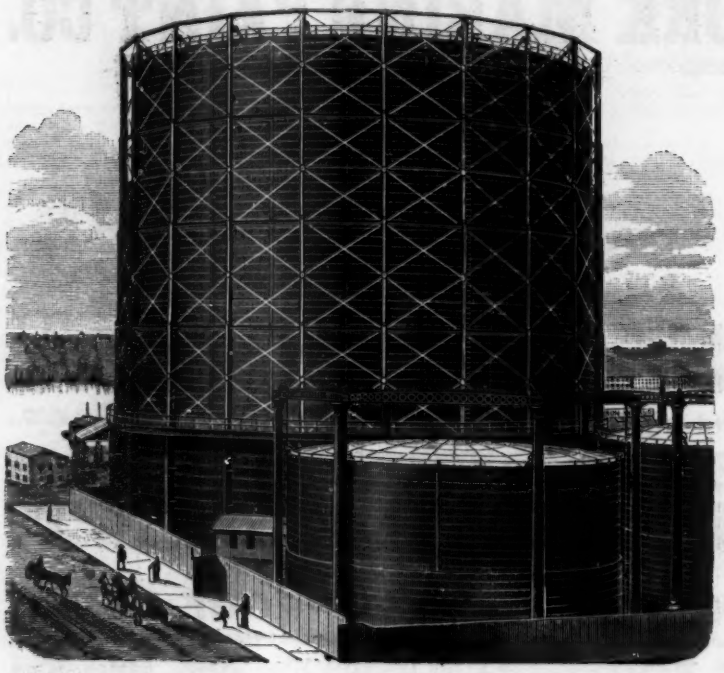

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Brunswick, Ga.	Norwich, Conn.	Mount Vernon, N. Y	Tacoma, Wash.	So. Chester, Pa.
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New Rochelle, N. Y.	San Diego, Cal.	Concord, N. H.	Pottstown, Pa.	Auburn, N. Y.
Salem, N. J. (3d)	Westerly, R. I.	Dover, Del. (2d)	Victoria, B. C.	DesMoines, Ia.
Omaha, Neb. (2d)	Northern Gas Lt. Co., of New York, N. Y.	Calais, Me.	Vancouver, B C.	Brooklyn, N. Y.
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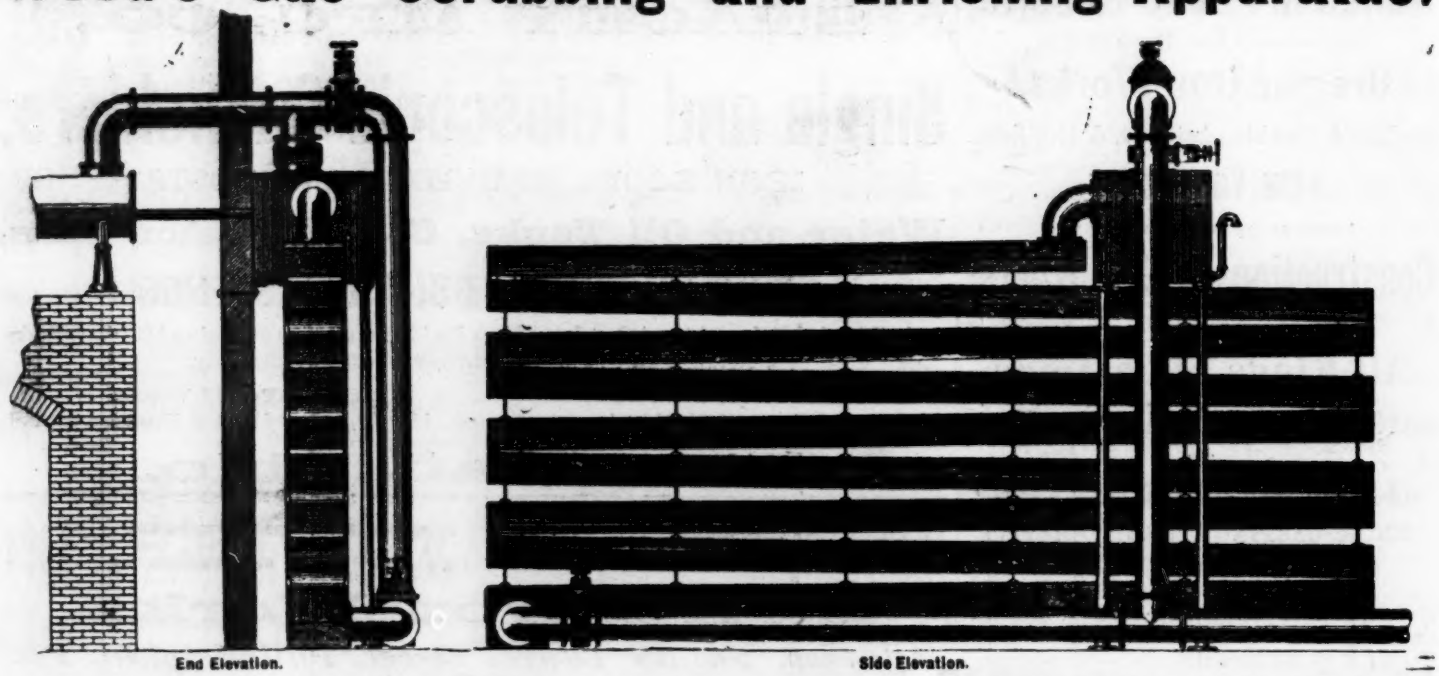

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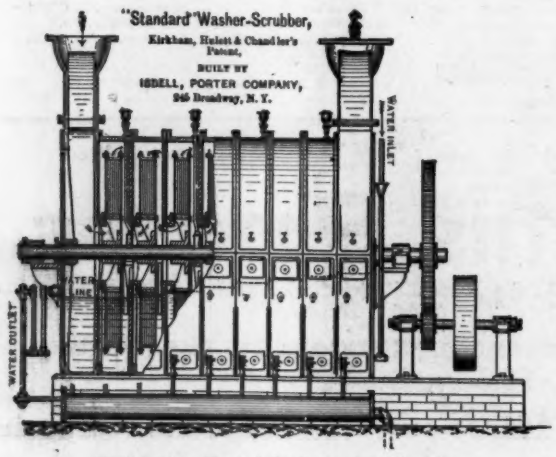

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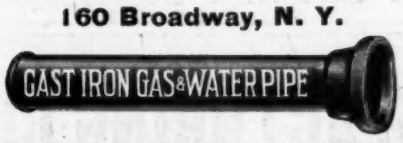

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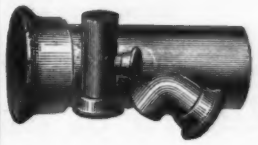

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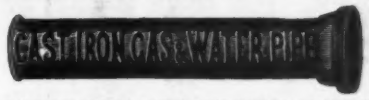

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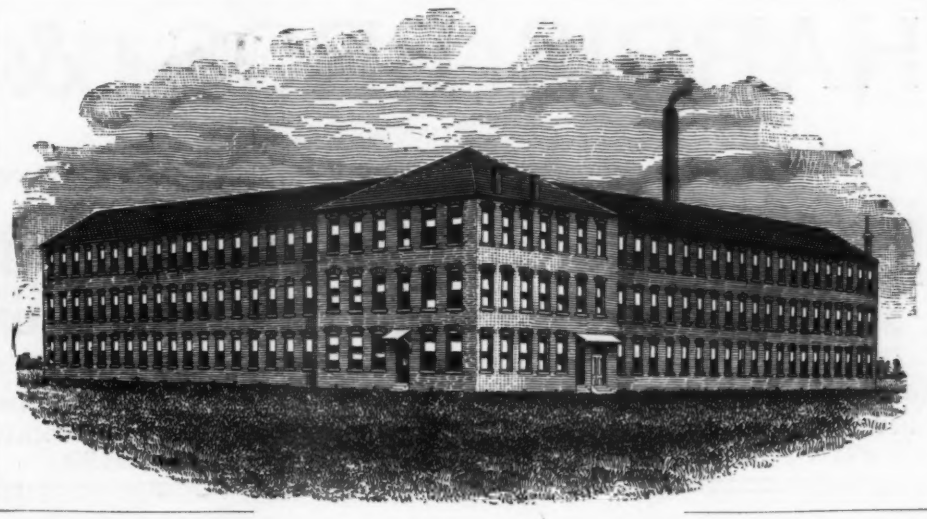

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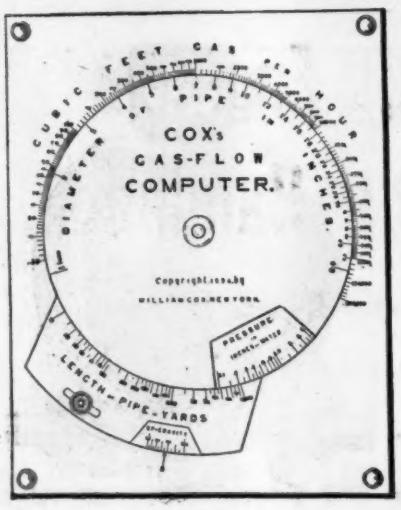

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